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RESEARCH AND DEVELOPMENT FY 1992

Intersociety
Working
Group

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Committee on Science, Engineering, and Public Policy
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Preface

This report is the sixteenth in an annual series of analyses of research and development in the federal budget begun by Willis Shapley under the auspices of the AAAS Committee on Science, Engineering and Public Policy in 1976. Managed by a team at AAAS, the effort now involves contributors from 22 scientific, engineering, higher education and industrial associations known collectively as the Intersociety Working Group. The main purpose of the report is to make available to the scientific and engineering communities and to policymakers timely and objective analyses of the Administration's proposed budget for research and development.

This report continues two features introduced last year. The Industrial Research Institute has prepared a chapter on trends in funding of R&D in industry. In addition, the AAAS Directorate for Education and Human Resources Programs has contributed a chapter on funding for science, engineering and mathematics education in the FY 1992 federal budget. Although neither of these are concerned strictly with R&D in the federal budget, they deal with closely related funding and policy matters that help define the context within which federal R&D is discussed and debated.

The President's proposed budget for FY 1992, released on February 4, was again presented in the form of a single mammoth volume of just over 2,000 pages (last year facetiously dubbed "The Onebook", after a recent publishing venture that tried to combine the commercial "yellow pages" of the District of Columbia, Maryland, and Virginia into one volume). Its coverage of R&D issues was more integrated and coherent than last year, however. Instead of being scattered across different thematic sections, this year's budget contained a well-written, analytical chapter covering most federally supported R&D, "Enhancing Research and Development and Expanding the Human Frontier," located within a large section entitled "Investing in the Future." Coverage in this 42-page chapter makes the task of locating budgetary details less problematic than last year's structure.

This report is one of several publications and activities of the AAAS R&D Budget and Policy Program. In addition to functioning as a stand-alone document, the report is intended to serve as background for the Sixteenth Annual AAAS Colloquium on Science and Technology Policy held in Washington, D.C. on April 11-12, 1991.

The Proceedings of the S&T Policy Colloquium will be published by AAAS in the summer. In the fall or winter, after Congress has completed its appropriations process, AAAS, in collaboration with the Intersociety Working Group, will publish its annual review of the impact of congressional decisions on R&D, Congressional Action on R&D in the FY 1992 Budget. Registrants for the Colloquium will receive copies of the Colloquium Proceedings, as well as the Congressional Action Report.

The structure of this report parallels that of recent editions. Part I, the overview, includes discussions of the budgetary context of R&D and major funding trends, as well as analyses of funding for basic research and R&D in colleges and universities. The chapters on R&D in industry and funding for science, engineering and mathematics education are also included in Part I. A set of overview tables appears at the end of this section.

The chapters in Part II examine the proposed R&D budgets of major federal agencies and departments. Tables detailing these budgets and the budgets of several smaller agencies and departments not included in the chapters are included at the end of this section.

Finally, Part III consists of a set of cross-cutting analyses that look at the budget in terms of disciplines and areas of research.

Readers should be aware that the chapters in this report have been prepared largely independently of one another and under extremely tight deadline pressure. Although every effort has been made to avoid them, some overlap, errors, and inconsistencies among the chapters are, unfortunately, inevitable.

On behalf of the members of the Intersociety Working Group, we would like to express our appreciation to the officers, members, and staffs of the participating organizations for their support and assistance in preparing this report. Our thanks also to the AAAS Committee on Science, Engineering and Public Policy, which initiated the R&D Program and periodically reviews it and provides guidance to it. We are very grateful to the individuals in the Office of Management and Budget, in other federal agencies, on congressional staffs and elsewhere, who aided us in collecting the information and advised us on its interpretation. We also owe special thanks to several AAAS staff members for their dedication and heroic efforts in preparing this volume for publication: Beth Goodrich and John Schoneboom of the Directorate for Science and Policy Programs; Sue O'Connell, Liz Carroll, and Jacki Vanasse of the Office of Publications; and our former colleague Susan Sauer, who recently accepted a position in private industry.

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Washington, D.C.
March 1991

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GENERAL NOTES

BASIS OF BUDGET STATISTICS

Budget statistics are presented on three bases: (1) **budget authority**, corresponding to the funds appropriated each year; (2) **obligations**, indicating the amounts of contracts and grants entered into; and (3) **outlays**, representing the amounts actually expended. Because budget decisions in the Executive Branch and in Congress are almost always made in budget authority, this basis most accurately reflects current changes in budget policies. Outlay trends lag a year or more behind decisions in budget authority, and obligations estimates are often adjusted to meet fiscal or budget strategy demands. We have, therefore, selected budget authority as the most meaningful measure of budget decisions and trends and used it in nearly all cases throughout the report.

BASIC RESEARCH, APPLIED RESEARCH, AND DEVELOPMENT

The allocation of agency budgets among basic research, applied research, and development is not an exact procedure; a certain arbitrariness is inevitably involved. The severe time pressures under which these figures are compiled for OMB are also a problem. Nevertheless, there is presumably some consistency within each agency's estimates so that the trends are meaningful.

ROUNDING NUMBERS

Due to rounding in the tables, the detail may not add to the totals and the percentage changes may not correspond exactly to the differences shown.

Part I: Overview

Chapter 1

Overview and Policy Issues for FY 1992

American Association for the Advancement of Science

Margaret O. Meredith, Kathleen M. Gramp
Albert H. Teich, Stephen D. Nelson

Overview

A. Political and Economic Context of the FY 1992 Budget

The FY 1992 budget cycle began with little fanfare, overshadowed by the dramatic events in the Middle East. Now that tensions appear to be easing (at least as of this writing), lawmakers can focus their attention on how to finance the "new world order." R&D is certain to be part of the equation, given the performance of the military's technological wizardry in "Operation Desert Storm."

Until the cease fire on 27 February, economists had lingering doubts about the effect of the Persian Gulf War on the economy and the budget. During the war, most forecasters hedged their bets, saying that the 1990-1991 recession would be short and mild if hostilities were over by the end of March. Policymakers hope this prognosis comes true, now that troops expect to start returning before Ramadan.

Quick closure of the war effort also bodes well for the federal deficit. Not counting the full costs of Operation Desert Storm, the Office of Management and Budget (OMB) estimated that the deficit for this year would hit a record-breaking $318.1 billion. According to press reports, the operation could add over $40 billion to the FY 1991 deficit after adjusting for foreign contributions.

Whether high or low, the budget process will not be held hostage by the war's costs. Last year's budget reforms, enacted after months of agonizing debate, temporarily abandoned the fixed deficit targets in the Gramm-Rudman-Hollings law. Losses caused by a weak economy, a war, or other external factors no longer require offsetting savings from spending or taxes. (For details on how Congress shaped the FY 1991 budget and the effects of its decisions on R&D, see Congressional Action on R&D in the FY 1991 Budget, published by AAAS in December, 1990).

Under the new rules, lawmakers are accountable only for red ink of their own making. Discretionary programs are subject to specific limits, enforceable by a series of sequesters if appropriations exceed the caps. New entitlement and tax measures must be financed on a "pay-as-you-go" basis.

All of the government's R&D programs fall in the "discretionary" category. The Budget Enforcement Act of 1990 (BEA) divided discretionary programs into three groups, with separate caps for defense, nondefense, and international affairs. For FY 1992, the BEA allows the nondefense category to keep pace with inflation, rising by about 4 percent above FY 1991 levels. Budget authority for defense, which includes the atomic energy programs at the Department of Energy (DOE), can grow by less than one percent.

If the new rules hold, the budget process may indeed become a "zero-sum" game. To break even, proponents of real, inflation-adjusted increases for one program must be prepared to swallow cuts in another. It pits domestic priorities against other domestic programs, defense against defense.

President Bush entered the fray on 4 February with his budget blueprint for FY 1992. R&D emerged as one of the Administration's top priorities. Under the White House plan, funding for nondefense R&D would increase by 9.5 percent (to $31.1 billion), compared to 4 percent for nondefense discretionary programs overall. Defense R&D fared even better than its other military compatriots, posting a 12 percent jump from current levels (to $44.5 billion). Added together, R&D would receive $75.5 billion in FY 1992 under the President's plan, 11 percent more than appropriated for this year.

The Administration appears willing to pay for the increase in nondefense R&D by cutting other domestic priorities. OMB tables show that its plan would skew appropriations allocations in favor of the Veterans Affairs-HUD-Independent Agencies (VA-HUD) subcommittee (up 7.8 percent), at the expense, for example, of the Labor-HHS-Education subcommittee (down 0.3 percent). Within defense, the White House made cuts in military procurement, personnel, and construction to make room for higher R&D spending.

Few expect Congress to tolerate such an uneven distribution of money. Flat funding for the Labor-HHS category would spell trouble for NIH, which is seeking a 7-percent increase for R&D. Even the generous gain implied for the VA-HUD bill cannot accommodate the growth proposed for its R&D agencies without reducing housing or veterans services. (The request assumes increases of 16.7 percent for both the National Aeronautics and Space Administration, and National Science Foundation; and 8.8 percent for the Environmental Protection Agency.)

Sorting out these priorities will be difficult. In the aftermath of the war, some argue that the nation must reinvest in its human resources, proposing initiatives in education, housing, and unemployment aid. At the same time, the dazzling performance of the military's "smart bombs" and Patriot missiles has bolstered support for American technology. Pressure to breach the spending caps will undoubtedly build as lawmakers try to pick among such priorities.

Within the R&D arena, Congress also must weigh the relative merits of "research" and "development." Among nondefense programs, the White House clearly favors research: it receives 74.1 percent of the $2.4 billion increase proposed for that category. The trend is reversed for defense R&D, where development and testing activities consume 89.8 percent of the $4.6 billion increase. The dominance of defense programs in the federal R&D effort means that 64.3 percent of the requested growth would be for development.

To help prepare for the upcoming debate, Table I-1 shows how the R&D budget compares with the U.S. budget as a whole. The table presents OMB's estimates of outlays for fiscal years 1990 through 1992 by major spending category. Under the Administration plan, the federal deficit would total $280.9 next year.

OMB expects defense R&D to hover at about 14 percent of defense spending, and nondefense R&D to absorb a similar share of "other government" outlays. (Figures for the "other" category may be distorted by expenses related to the S&L bailout.) Because of the limits on budget authority for defense, OMB anticipates outlays for military programs to fall 1.2 percent in FY 1992, but it projects outlays for defense R&D to increase 6.4 percent. Similarly, outlays for nondefense R&D are expected to increase faster than other programs in the "other" category.

Table II-2 gives OMB's forecast of future outlay trends. It shows outlays by major areas for fiscal years 1992 through 1996 assuming the President's proposals. The estimates assume that defense outlays wili inch downward through FY 1994, but rebound after the limits in the BEA expire. Outlays for the "other government" category would drop more precipitously, falling

60.2 percent between FY 1992 and FY 1995. This decline reflects the ebb and flow of the S&L bailout, which is expected to generate savings to the government by FY 1995. As in defense, outlays for "other" programs wili rise once the caps are lifted.

B. R&D in the FY 1992 Budget

The remaining tables in Part I (Tables I-3 through I-13) highlight some of the key features of the President's R&D budget for FY 1992. Statistics on the Administration's agency proposals are presented at the end of Part II. The first table of that section (Table II-1) shows the total R&D request by agency. More detailed information for the R&D programs of the major agencies appears in tables II-2 through II-21. Part II provides analyses of R&D budgets for major agencies. Cross-cutting disciplinary analyses are presented in Part III.

Table I-3 shows how R&D funding is distributed between national defense and civilian objectives. Evident in this table is the reinstatement of the ten-year trend, interrupted only last year, of allocating most of the proposed growth for R&D funds to defense. The President's budget request contains $44.5 billion for defense R&D (including defense programs at the Department of Energy), representing an increase of 12 percent over the FY 1991-enacted level. This request contrasts with last year's budget proposal for defense R&D, which failed to keep up with inflation. An increase of $2.7 billion is proposed for civilian R&D programs, bringing the total to $31.1 billion. This 9.5-percent increase in civilian R&D is two percentage points below the proposed growth for these programs in last year's budget proposal.

Table I-3 also shows funding for defense and nondefense for the three common measures of budget transactions. (See "General Notes" at the front of this report for definitions of these terms.) For defense R&D, obligations would rise faster than budget authority, and budget authority faster than outlays. In contrast, budget authority outpaces outlays (although, not by much), and outlays outpace obligations in nondefense R&D.

Some highlights of the Bush budget for R&D include the following:

- Although the Administration has recommended that the lion's share of the new money be directed to defense R&D programs, the FY 1992 budget includes healthy increases for several civilian programs. Table I-4, which provides R&D funding by major component, shows Space, Health, and General Science as receiving significant increases over the FY 1991 levels.

- Space (which excludes space applications and aeronautics) taps almost a third of the proposed growth for nondefense R&D. When the remainder of the R&D programs at the National Aeronautics and Space Administration (NASA) are included, the agency claims half of the new money proposed in FY 1992.

- Most of the remaining increase is distributed nearly equally between Health and General Science. The proposed funding for Health is 5.1 percent above the FY 1991 level in current dollars. (Health programs include the Departments of Health and Human Services and Veterans Affairs and health programs at the Department of Education and the Environmental Protection Agency.) General Science, which is comprised of the National Science Foundation and the Department of Energy's General Science program, grows 22.6 percent.

- Energy is the only major R&D component proposed to decrease in the FY 1992. Energy R&D is slated to fall 3.1 percent below the FY 1991-enacted levels.

- Table I-5 displays the budget request for R&D by character of work. Development increases 12.9 percent over FY 1991, which corresponds to the large share of the new R&D money being channeled into defense programs. Applied research grows 7.9 percent under the FY 1992 plan, outpacing basic research, which is proposed to increase 6.5 percent over FY 1991 levels.

- Table I-6 presents additional detail on the defense/nondefense split in R&D by character of work. Defense activities in basic research are proposed to fall in FY 1992. Much of this decrease results from the deletion of pork-barrel items included by Congress in FY 1991. Nondefense activities continue to account for nearly three-quarters of applied research. Finally, defense programs continue to dominate development, with their share holding steady at about 84 percent.

- Within the nondefense category basic and applied research are proposed to grow at nearly the same rate, 8.5 percent and 8.6 percent, respectively. The growth in basic research among civilian R&D programs can be attributed to proposed increases for the National Institutes of Health, NASA, and NSF.

- Table I-7 shows the distribution of R&D among the agencies. The additional $4.5 billion proposed for DOD brings the agency's total to $41 billion in FY 1992 and restores the long-time upward trend in defense R&D temporarily curtailed last year. The growth in R&D funding at DOD is allocated somewhat unevenly among defense programs. The largest increase in absolute terms ($2 billion) goes to the Advanced Technology Development program, which includes the Strategic Defense Initiative. Strategic programs and Intelligence and Communications increase 21.1 percent and 37.4 percent, respectively, while activities within the Technology Base program, which contain basic research, decrease 0.6 percent.

NASA is the big winner among the civilian agencies, receiving about half the total increase for nondefense R&D. The increase is due to the high priority being given to the Comet Rendezvous/Asteroid Flyby (CRAF)/Cassini mission, the Advanced Launch Vehicle, which will provide NASA with a heavy lift capacity, and the Advanced X-ray Astrophysics Facility. A modest increase of $128 million is requested for the space station in response to a congressional mandate to reduce the program by $6 billion over the next five years.

Under the FY 1992 plan, the Department of Health and Human Services would increase 5.4 percent, with over 95 percent of the added funds going to NIH. Of the additional $538 million allocated to NIH, research project grants would get $395 million. Most of the increase proposed for these individual investigator grants would support noncompeting continuations. The proposed increase for NIH is spread relatively evenly among the institutes. The two exceptions are the Human Genome Project, which would rise from $83.3 million in FY 1991 to $105 million in FY 1992 (a 26-percent increase in current dollars), and the Division of Research Resources, which is slated to decrease 8.8 percent. ADAMHA would receive a sizable increase -- $85.2 million or 8.4 percent. Finally, research on AIDS among the HHS agencies would rise 6.3 percent over the FY 1991 level.

After four losing seasons, the presidential initiative to double NSF's budget is still being pursued. The FY 1992 budget proposal tries to get NSF "back on the doubling track," with an increase of 16.7 percent to a total of $2.2 billion for R&D. This level compares with $1.9 billion appropriated in FY 1991. The FY 1992 request bolsters support for individual investigators and their research infrastructure, which would receive 75 percent of the new money. This emphasis on "small science" is illustrated by the growth proposed for each of NSF's directorates, which ranges from 12.7 percent to 23.3 percent among the research directorates and is 21.0 percent for Education and Human Resources.

The budget request for NSF also contains $50 million for a new presidential initiative for a competitive, cost-sharing program for state-of-the-art instrumentation. In addition, some $113 million is requested for NSF's contribution to the government-wide initiative in High Performance Computing and Communications (HPCC).

R&D programs at the Department of Energy are proposed to increase 8.5 percent to almost $8 billion in FY 1992. General Science, the Department's basic research program, fares exceptionally well with a 34.6-percent increase over the FY 1991 appropriated level. The Department's budget request contains about $395 million in new money for basic research programs, with the lion's share allocated to the Superconducting Super Collider. Conversely, DOE's energy programs undergo a 1.8 percent cutback. The major targets for the cuts are Fossil Energy (down 53 percent) and Clean Coal Technology (down 20.8 percent). Holding true to his vow to improve conservation, President Bush has requested an increase of 27.2 percent for Energy Conservation programs. The budget proposal also provides a 9-percent increase in funding for Atomic Energy Defense Activities (AEDA). Included in this new money is a 60.3-percent increase in Environmental Restoration and Waste Management.

Of the smaller R&D agencies, the National Institute of Standards and Technology led the pack with an increase of 16.6 percent. EPA also came out ahead with an increase of 8.7 percent over the FY 1991-enacted level. Much of this increase will be channeled into monitoring and characterization research as a result of the mandates contained in the Clean Air Act. Increases proposed for climate-related research as part of the government-wide initiative on Global Change offset significant cuts in R&D funding at the National Oceanic and Atmospheric Administration.

The Department of Agriculture would grow just 0.7 percent under the FY 1992 plan. USDA's budget, however, does include substantial growth for the National Research and Global Change Initiatives, which was offset in part by the exclusion of congressionally earmarked funds in FY 1991.

Table I-8 shows the proposed funding levels for basic research among the agencies, and Table I-9 provides the estimated support for R&D at colleges and universities. The major recipients of the $807.6 million increase for basic research are NIH ($375.4 million), NSF ($268 million), and NASA ($262 million). Agencies' estimated support for R&D at colleges and universities shows NSF as receiving the majority of the added funding in FY 1992, with an increase of 15.4 percent, followed by NIH, whose percentage increase was less than half NSF's rate.

C. Prospects for R&D in FY 1992

Although Congress has consistently provided generous increases in R&D support since the early 1980s, the new budget process may make it more difficult to raise spending at the rates proposed by the President throughout the decade. The caps placed on defense, foreign aid, and domestic discretionary spending combined with the requirement to project five-year spending levels will probably limit what Congress can do for R&D this year.

There is no doubt that the $75.5 billion in R&D embedded in the $1.45-trillion budget will face tough challenges in Congress this year. If Congress is to stay within the overall spending limits, increases in funding for science and technology must be offset with cuts in other programs. The budget includes about $18-billion worth of cuts, which more than compensate for the proposed increases in R&D. However, they include housing support, urban mass transit, and several other programs favored by influencial constituencies on Capitol Hill.

The Administration may have an especially difficult time defending "big science" this year. The space station, SSC, and Human Genome Project were all under fire last year. The big increases proposed for these programs this year may make them more vulnerable under the new budgetary climate.

The budget proposal includes some new agenda items, particularly the new government-wide High Performance Computing and Communications initiative which promises to increase the performance of advanced computing by three orders of magnitude. At a total of $638 million--three and a half times the request for the Human Genome Project--it joins the ranks of the "big science" projects, but it's hard to predict how Congress will treat it. (Both of these projects differ from other "big science" projects in the respect that they are made up of many individual parts.) In addition the budget contains a smaller initiative in materials science at NSF.

The budget makes it clear that the Administration feels congressional earmarking is getting out of hand. The budget includes an unprecedented section devoted to earmarking of funds, and identifies some 492 such earmarks totalling $810 million in FY 1991. (Of these, 325 earmarks worth $182 million were customary earmarks made in the Department of Agriculture's budget.) At the same time, the Adminstration proposes cutting the only major federal program that provides support for university facilities -- a $20-million NSF program begun last year. Whether or not the elimination of the facilities program will increase the pressure for Congress to add pork remains to be seen.

How Congress will treat these issues remains uncertain. The recent war in the Persian Gulf will add another dimension to the budgetary debates, and will provide the impetus to reexamine defense spending and the nation's energy policy. Whatever the outcome, it is hoped that the new budget process will eliminate many of the budgetary mechanics which have guided budgetary decisions through the 1980s, and help to unmuddy (to some extent at least) the nation's priorities for science and technology.

Chapter 2

Special Analyses

American Association for the Advancement of Science

Stephen D. Nelson, Albert H. Teich
Margaret O. Meredith, Kathleen M. Gramp

This chapter offers brief overviews of several important areas of R&D trends. These include federal funding of basic research, federal support for R&D at colleges and universities, and a broad look at the major national performers and funders of R&D. The tables supporting this discussion are found at the end of Part I. Trends in industrial R&D, which until last year were covered briefly in this chapter, are now the subject of a separate chapter following this one.

A. Basic Research

The Administration has explicitly featured support for basic research as a priority in most of its key public discussions to date of the proposed budgets for R&D — in the budget book itself, in presidential science advisor D. Allan Bromley's press conference on budget-release day, and in Bromley's statement in OSTP posture hearings before the House Committee on Science, Space, and Technology.

Federal support for basic research by agency is shown in Table I-8, with FY 1982 figures as a comparison point. It is important to note that the figures for basic research shown in this table are not actually direct budget proposals, but rather are estimates of basic research funding derived from proposed budget data. Agencies present their requests in programmatic terms, and then estimate the amounts that would be spent on different types of R&D based on those requests. Further, interpretations of the definition of basic research are not uniform across agencies, and each agency makes its own distinctions as to type of R&D and estimated spending for each. Consequently, the data reported here are imprecise although generally suggestive in the aggregate.

In the budget proposed for FY 1992, support for basic research would increase from $12.5 billion to roughly $13.3 billion, an increase of about $0.8 billion, or 6.5 percent in current dollars and 2.2 percent in constant FY 1982 dollars. These rates of increase are lower than those for R&D overall (11 percent in current dollars and 6.6 percent in constant dollars).

The above figures differ somewhat from those reported in other sources which have used the numbers reported by OSTP and the Office of Management and Budget. The key difference concerns not the FY 1992 proposed budget figures, but the FY 1991 estimates. The 101st Congress added approximately $170 million to the Department of Defense's (DOD) basic research request, for items such as earmarks in the University Research Initiative program, graduate fellowships and traineeships, and a U.S.-Japanese management program. These figures were apparently not reflected in the OMB figures, but they have been included in the tables in this book. This has the effect of raising the base from which percentage changes are figured, and creates a "blip" in the trend line for DOD basic research.

Basic research has grown in both absolute and relative terms over the past decade or so. The FY 1992 estimates are 70 percent higher than in FY 1982 after correcting for inflation — an average real growth rate of about 5.5 percent per year compounded. (Against this standard, the proportional increase in basic research estimated for FY 1992 is lower than the average rate of increase over the past ten years.) In addition, basic research has generally grown over the years in its proportion of total federal R&D support, going from 10.5 percent in FY 1967 and settling into the range between 15 and 18 percent in the past few years. FY 1992's figures represent 17.6 percent of total federal R&D (see Table I-5).

In comparing defense and nondefense support, in the past few years roughly 90 percent of federally supported basic research has been nondefense, as shown in Table I-6. (In this table, defense includes, in addition to DOD, the Department of Energy (DOE) military-related programs.) For FY 1992 this figure would be 92 percent nondefense. Defense basic research for FY 1992 (of which 97 percent is DOD) continues its recent pattern of very slow or no growth. Because of the "blip" in the FY 1991 figures, defense basic research for FY 1992 is expected to fall by nearly $160 million (a decrease of 13 percent in current dollars and almost 17 percent in constant dollars). Perhaps a better gauge of the FY 1992 figure relative to its recent pattern is to look at its growth over the past two years. Since FY 1990, the increase in defense support for basic research has been about 8 percent in current dollars, which represents almost no growth in actual spending power. By contrast, nondefense basic research in FY 1992 would increase by 8.6 percent over FY 1991 to nearly 12.3 billion, representing real growth of 4.3 percent. Over the past two years (since FY 1990), nondefense basic research funding has increased about $2 billion, or about 19 percent in current dollars and about 11 percent in real growth.

Turning to the agencies (Table I-8), the overall pattern is largely one of increases in basic research support, although some are less than the rate of inflation (technically, the deflator adjustment). NIH continues its long-standing role as the largest single federal supporter of basic research. Its estimated total, nearly $5 billion, would represent 37.3 percent of all federally supported basic research, roughly the same proportion as the past two years. NIH's basic research in FY 1992 is expected to increase 7.2 percent in current dollars (3 percent in constant dollars), slightly above the overall rate of increase for basic research. Within NIH, the Human Genome Project would be increased by 26 percent, from $135 million to $169 million. All other basic research in NIH would increase by 6.7 percent.

Agencies receiving significant increases in basic research include, among the larger R&D agencies, NASA and NSF, which would each grow by nearly 16 percent. However, since these agencies are handled within the same appropriations subcommittees, it will be difficult for them both to sustain the proposed increases in the course of running the congressional budgetary gauntlet. Among the mid-size to smaller R&D agencies, the Environmental Protection Agency would receive the largest proportional increase in basic research support, nearly 23 percent in current dollars.

The other significant players in the federal basic research support game are the Departments of Energy, Agriculture, and Interior. DOE would receive an increase of $18 million, only about 1 percent in current dollars and a decrease of 3 percent in constant dollars. DOE proposes an increase of nearly $27 million for basic research components of the Superconducting Super Collider (SSC), going from $108.9 million to $135.7 million, an increase of nearly 25 percent. By contrast, all other basic research within DOE — comprising over $1.6 billion — would decrease by about $9 million, a decrease of 0.6 percent in current dollars, and a decline in purchasing power of almost 5 percent.

The USDA's basic research would increase by about $36 million, or about 6 percent, boosted by a 71 percent increase in the National Research Initiative to $125 million. However, apart from the $52 million increase in the NRI, the rest of USDA basic research would decrease by a total of $16 million, or about 3.3 percent in current dollars and more than 7 percent in constant dollars. Interior's basic research funds would decline by nearly 10 percent in current dollars (13 percent in constant dollars), with decreases occurring both in the U.S. Geological Survey and the Bureau of Mines.

Details regarding the specific effects of these trends within each of the agencies can be found in the relevant chapters in Parts II and III of this book.

B. Colleges and Universities

Federal support for R&D in colleges and universities has become more visible as a public policy issue, as scientists have become more vocal about the squeezes they experience in trying to secure funding for their research. The data on expected federal support for R&D in colleges and universities are shown in Table I-9. In this area the picture for FY 1992 is more mixed than that in basic research. We should emphasize -- as we did for basic research above -- that these data do not represent direct programmatic decisions, but are after-the-fact estimates of how much funding is likely to go to colleges and universities under program levels contained in the budget request.

Overall, the total of federal R&D support to colleges and universities is expected to increase somewhat by 4.3 percent to about $10.3 billion. However, nearly all of this increase in current dollars would be offset by inflation, leaving negligible real growth (0.2 percent). Real growth in the two years between FY 1990 and FY 1992 would be almost 5 percent under the proposed budget.

Federal agencies fall into three fairly distinct tiers, in terms of their amount of support for R&D in colleges and universities. Within the top tier, NSF would receive the largest growth of such funds under the proposed budget, with an increase of $209 million or over 15 percent in current dollars (nearly 11 percent in constant dollars). NIH and its parent department, Health and Human Services, would receive a more modest increase, nearly 7 percent. However, NIH would still furnish almost 47 percent of all federal funds going for R&D in colleges and universities. DOD's support in this area would decrease sharply, at a rate of almost 13 percent in current dollars and over 16 percent in constant dollars.

Within the second tier of agencies, NASA's support would increase by $67 million, or almost 13 percent in current dollars (8 percent in constant dollars). The USDA's support in this area would be essentially static in current dollars (a 0.1 percent decrease) but would decrease by 4 percent after inflation is taken into account. The Energy Department's support for R&D at colleges and universities is expected to fall by almost 12 percent in current dollars and by 15 percent in constant dollars.

Below these two tiers are several other agencies which present a mixed picture in terms of R&D support in colleges and universities, ranging from an increase of 44 percent in the Commerce Department to a decrease of 31 percent in the Interior Department.

C. National Patterns of R&D

Table I-10 shows the national patterns of R&D spending estimated by NSF for calendar year 1991, arraying sources of funds against R&D performers. NSF estimates that total national spending for R&D in 1991 will be $151.6 billion, an increase of 1.3 percent in current dollars but a 7 percent decrease in constant dollars over the two-year period 1989-1991.

Federal spending is expected to account for $66 billion, or 43.5 percent of national R&D spending. Last year the expected federal spending level was 46.2 percent of the national totals. Industry is expected to spend about $78 billion, or 51.5 percent of national totals. Industry's total is 5.5 percent higher than that for last year, and its share of the national totals is expected to go from 49.4 percent last year to 51.5 percent this year. Funding of R&D by (a) colleges and universities and (b) nonprofit organizations is still relatively small (3.3 percent and 1.7 percent of total national R&D spending, respectively). However, these were the fastest-growing segments in the past two years, with each showing about 15 percent growth in constant dollars.

The primary performer of the nation's R&D continues to be industry, which performs almost all (97.6 percent) of the R&D that it supports, plus 49 percent of all federally supported R&D. Its total of R&D performance is over $108 billion, or 71.5 percent of total national R&D.

Colleges and universities are expected to perform about $17.2 billion of the nation's R&D in 1991, or about 11.3 percent of total national R&D spending. About 56 percent of those funds are expected to come from the federal government, with another nearly 29 percent supported by colleges and universities themselves. Industrial support for R&D performed by colleges and universities -- the subject of much attention for nearly a decade — continues to grow at a substantial pace, almost 17 percent in constant dollars over the past two years. It is expected to total $1.25 billion in 1991. However, it is still the smallest source of R&D funds for colleges and universities. This figure represents 1.6 percent of all R&D supported by industry, up very slightly from 1.5 percent last year.

Chapter 3

R&D in Industry

Industrial Research Institute

Charles F. Larson

The Situation

For industrial R&D in the United States, these may be the best of times and the worst of times. Funding of industrial R&D is at an all-time high. The infrastructure and people are superior. At the same time, some believe that R&D productivity and credibility are suspect. This view is due to a wide variation across industries in addressing the challenges of global competition. Indeed, while most large companies continue to increase their R&D budgets, many mid-size and smaller companies are cutting, if not eliminating, R&D. It seems that just as technology has become critically important to the global competitiveness race, R&D has become less important in some sectors.

Battelle has forecast that industrial R&D spending will be $75.9 billion in 1991, up only 2.2% over 1990. Other forecasts, including that of the Industrial Research Institute (see "Current Trends"), are not quite so pessimistic. Whatever the actual figure may be, these projections are at or barely ahead of inflation, meaning that R&D spending is stagnant in this country. In contrast, real increases of 4% to 8% more than inflation are being projected in other countries, such as Japan, Germany, and France.

These trends and others will be discussed later in this article. The next two sections outline some short-term and long-term challenges to directors of industrial R&D.

Short-Term Challenges

The deceleration in industrial R&D spending presents some stimulating and immediate challenges to research directors. A list of such challenges was recently compiled, based on input from some 20 research directors from major corporations who attended a meeting of the Industrial Research Institute's (I.R.I.) Research-on-Research Committee in February 1991. In descending order of times mentioned, these short-range challenges follow, with comments on how they propose to address each problem.

1. Integration of Technology with Strategic Planning

- Promote improved awareness of the capabilities of R&D through better internal communication.
- Create R&D/operating division task groups.
- Serve as the agent of change in the company.
- Raise performance expectations.
- Promote a longer-range view.
- Take better advantage of outside sources of competitive advantage.
- Analyze R&D as providing strategic options that can be exercised at a later date.

2. R&D Productivity

- Improve metrics, i.e., techniques of measuring output as well as input.
- Improve project selection.
- Improve project management.
- Hire better people and improve training of current staff.
- Implement total quality management.
- Enhance communication and cooperation with other parts of the company.
- Relate return on R&D to current time frame instead of sales at a future date.

3. Reduction of Time from Laboratory to Marketplace

- Integrate the enterprise.
- Establish clear goals.
- Understand the market through better coordination with marketing and manufacturing.
- Move R&D people in and out of other corporate functions.

- Improve rewards and recognition.
- Foster discontinuous innovation.
- Promote a creative environment.
- Implement total quality management.
- Improve technology transfer.
- Eliminate, or reduce, the NIH--not invented here—factor.

4. Globalization of R&D

- Improve world-wide integration of R&D strategies and projects.
- Clarify the corporate technology plan and champion it throughout the company.
- Identify key technologies and assess their state within the company.

5. Environment

- Re-address customer needs.
- Improve communication on risk-benefit.
- Consider life-cycle costs and impacts.
- Collaborate with national labs and universities.
- Focus on environmental technologies.

6. R&D Organization

- Assess movement toward decentralized units, perhaps of sub-critical size, in view of trends in other countries.
- Ensure overall technology coordination function.
- Take advantage of cultural diversity of scientists and engineers.

It is obvious that R&D directors intend to improve the credibility of their operation through stronger leadership within the company, through improved techniques of measuring R&D output, and through better communication both within and outside the company.

Long-Term Challenges

The I.R.I. Strategic Plan for 1991-1995*, issued last Fall, outlines 10 longer-range influences on industrial research in the first half of this decade. They are summarized below.

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*Copies are available at no charge from I.R.I., 1550 M St. NW, Washington, D.C. 20005 (202-872-6350)

1. Technology development will continue to occur more aggressively outside the U.S. Cooperative means to monitor, develop, or acquire technology worldwide will become increasingly important for U.S. industry.

2. Successful corporations will view intellectual property and technology as a strategic resource to be created, acquired, shared, or otherwise traded to gain world-wide market advantage. Participation in global markets will be necessary to sustain reasonable growth and to strengthen performance.

3. R&D organizations will be required to manage their activities against quantifiable business goals and objectives. They will be judged against productivity and quality measures in the same manner as other operating functions of the company.

4. Pressures for short-term results from U.S. industrial research laboratories will continue; financial and analytical tools will be used increasingly to assess and communicate the potential rewards and risks of longer-range programs. Reduced support for long-term research goals will threaten industrial competitiveness, and communication of convincing positive arguments will remain a critical necessity.

5. There will be fewer rigorously trained and well-motivated scientists and engineers, particularly of U.S. heritage, and research management will face growing challenges in retaining the best for long-term careers in technical roles and managing a multicultural work force.

6. The rate of expansion of knowledge will continue to increase. In view of the factors mentioned in (5), planning for extensive retraining of experienced scientists and engineers will be inevitable.

7. The image of science and technology will require regular attention to overcome negative perceptions generated by the media and by special interest groups; the industrial research community may find

it necessary to assume a leadership role in identifying and communicating the benefits of new technology to the business community and to the public.

8. Growing federal budget deficits will limit growth of federal R&D spending and pressure universities to seek more funding from industry. In addition, continuing trade deficits will prompt government to look to industry for stronger leadership in commercializing new technology. To meet increasing competitive pressures, alliances among academic, government, and commercial research laboratories will grow in importance in the practice of industrial R&D.

9. Issues of quality, environment, health, and safety will be the impetus for a new level of creativity in R&D, to permit industrial expansion to occur within the context of a more highly regulated climate.

10. The historic concepts of industrial R&D will be expanded and partially transformed by the inclusion of "service industries" as a growth factor.

The importance of improved credibility through leadership, metrics, and communication is also clear in these long-range challenges. The bottom line is that all companies have virtually equal access to technology. Successful companies will be those that combine other people's technology most efficiently with their own, are aware of existing and potential needs in the marketplace, and respond appropriately.

Current Trends

I.R.I.'s seventh annual survey of industrial R&D trends* was sent to 245 member companies in the United States, with 137 replies (a 56 percent response). Respondents were asked to estimate relative change in levels between 1990 and 1991 in the following categories: Expenditures; Effort Allocation; Personnel Trends; Other Trends.

As in previous years, a scale of 1-5 was used:

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*"Industrial Research Institute's Annual R&D Trends Survey," RESEARCH·TECHNOLOGY MANAGEMENT, January-February 1991, pp. 12-14

1 = "significantly less" (-5 percent or less)
2 = "slightly less" (0 to -5 percent)
3 = "approximately the same" (1 to 5 percent more)
4 = "slightly more" (6 to 15 percent)
5 = "significantly more" (15 percent)

Highlights of the survey follow:

- Despite uncertainties in the U.S. economy, 41 percent of the companies indicated that they will spend at least six percent more on R&D in 1991 than in 1990. Only 16 percent indicated that they expect to decrease their 1991 expenditures. This represented the seventh consecutive year that an overwhelming number of respondents planned to maintain or increase their R&D budgets. Surprisingly, it also represented some improvement over last year's projection in which 36 percent of the respondents expected an increase of six percent or more.

- Whether this optimism will translate to significant overall increases in industrial R&D spending is questionable, however, because the survey indicated that the respondents' combined R&D as a percent of sales was not expected to change from 1990 to 1991. A sluggish economy, therefore, would restrain actual R&D spending increases. It appears that the respondents may share this view because, on average, they have not projected manpower increases between 1990 and 1991.

- Allocation of R&D resources is likely to change in 1991. A shift was projected toward the support of existing businesses and new business projects, and this shift appeared to be somewhat at the expense of directed basic research. Thirty percent of the respondents expected a decrease in their basic research allocations in 1991, while less than half that number expected an increase. This compared to 40 percent of the respondents who predicted a shift toward new business projects and 29 percent who predicted an increase in R&D which supports existing businesses.

- This increased business focus may explain the projected shift by 19 percent of the responding companies away from centralized corporate R&D and toward divisional R&D. Only ten percent of the respondents foresaw greater centralization in 1991. The shifting focus also correlated with the projections that top management will continue to pay increasing attention to R&D, both with respect to research on longer-term or strategic issues and to development efforts. The increase in top management's attention to development represented the biggest expected year-to-year change of any item in the survey, with 55 percent of the respondents forecasting an increase.

- Among the other significant results of the survey was the acceleration of a multi-year trend that each year predicts more R&D effort will be expended in the subsequent year to respond to legislation, standards or other governmental rules. Among the current respondents, 48 percent predicted such an increase in 1991 vs. 38 percent in last year's survey and 28 percent in 1988.

- Another continuing trend was the expected increase in R&D participation in alliances and joint ventures. Forty-two percent of this year's respondents expected such an increase in 1991 vs. 33 percent last year and 40 percent the previous year. Only eight percent expected a decrease.

- In the area of licensing technology to and from others, modest increases were expected in both directions. The out-licensing expectations continued a multi-year trend, whereas the expectation of increased in-licensing represented a departure from the previous two years.

- Some increases were also expected in contacts with federal laboratories. This was a continuation of a three-year trend and could indicate a continuing positive response to legislation encouraging the transfer of technology from federal laboratories to industry.

- Participation in consortia for pre-competitive university research, however, was decreasing slightly, with eight respondents indicating they expect to do significantly less in 1991. This parallels the expected decline in basic research support and may also be indicative of the shifting R&D priorities toward a greater business focus.

- No dramatic changes were predicted in R&D professional manpower levels or in expectations for hiring new graduates. The 23 percent of respondents predicting manpower increases was offset by the same percentage predicting reductions. Similarly, the 21 percent of the respondents who predicted hiring increases in 1991 match a similar percentage of respondents who anticipated decreases. This year's predictions parallel last year's but mark a decrease from the optimistic hiring expectations of two years ago.

- Overall quantitative data did not predict any surprising changes from 1990 to 1991. Capital expenditures were expected to remain about the same as 1990 (15.2 vs. 15.4 percent of R&D budget), and R&D expenditures were expected to remain at 4.7 percent of sales, the same as in 1990. Operational costs per R&D professional were expected to be $162,700 in 1991, an increase of 2.6 percent over 1990.

Tabular results of the 1991 trends forecast are shown in Tables 1 and 2.

Table 1

Forecast of 1991 Trends by Industry

	R&D as % of Sales		Capital Expenditures for R&D as % of Budget			R&D Professionals as % of Total R&D Personnel		Operational Cost per R&D Professional (×$000)	
	1990	1991	1989	1990	1991	1990	1991	1990	1991
Food, Tobacco, & Kindred Products (11 companies)	1.0	1.2	8.1	8.5	9.8	61	61	141	146
Paper & Allied Products (6 companies)	1.1	1.1	13.9	16.7	12.7	53	54	142	145
Chemicals & Plastics (26 companies)	3.7	3.7	11.9	14.5	13.9	57	57	150	156
Petroleum & Related Industries (8 companies)	4.3	4.4	11.2	11.3	10.9	54	55	221	223
Primary Metal Industries (11 companies)	0.9	0.9	6.1	8.5	8.7	50	50	155	156
Machinery, Except Electrical (5 companies)	4.5	4.6	10.2	12.4	9.9	52	55	167	169
Electrical Machinery, Equipment & Supplies (6 companies)	7.5	7.1	14.1	12.1	15.3	49	56	148	157
Pharmaceuticals & Personal Care Products (16 companies)	9.5	9.2	20.5	27.1	29.3	57	57	145	153
Fabricated Metal Products (5 companies)	1.5	1.6	7.5	7.6	8.1	67	68	111	115
Other (43 companies)	6.6	6.4	14.9	16.9	15.8	59	58	178	180

Table 2

Survey Questionnaire Results

Expected Changes in 1991 Compared with 1990 Experience	Relative Change (no. of responses)						
	NA	1	2	3	4	5	NR
Expenditures							
1. Total R&D expenditures	0	4	18	59	54	2	0
2. Ratio of direct salaries and wages to other direct R&D costs	0	0	13	108	14	0	1
3. Capital spending for R&D operations	0	13	31	55	28	9	0
4. Subcontracting R&D to outside commercial organizations	12	3	18	78	21	0	3
5. Grants, contracts, etc. for university R&D	4	4	20	79	24	4	1
Effort Allocation							
6. Relative distribution of R&D costs:							
a. Support of existing business	1	1	15	80	33	6	1
b. Directed basic research*	11	7	31	70	18	0	1
c. New-business projects	1	9	19	52	47	6	2
7. Ratio of non-centralized (e.g., divisional) to centralized corporate R&D efforts	21	1	10	80	20	1	4
8. Outside-customer technical-service efforts relative to total R&D (in time or dollars)	8	0	11	82	31	1	2
9. R&D efforts in response to existing or proposed legislation, standards, or other governmental rules (in time or dollars)	5	1	0	66	52	9	1
Personnel Trends							
10. R&D professional manpower level	0	6	26	73	31	1	0
11. Hiring new graduates	5	8	18	70	24	1	0
Other Trends							
12. Top management attention to *Research* on longer term or strategic issues	1	8	13	51	59	6	0
13. Top management attention to *Development*	0	1	6	54	69	6	0
14. Participation in consortia for precompetitive university research	14	8	17	78	17	0	1
15. Participation in alliances and joint ventures for R&D	6	2	8	66	45	9	0
16. Licensing technology *from* others (dollar volume)	9	2	9	83	25	5	1
17. Licensing technology *to* others (dollar volume)	10	2	8	80	29	3	1
18. Extent of government financial support of R&D	41	1	18	53	13	1	5
19. Contacts with Federal Laboratories	30	2	5	66	23	4	2
20. Overhead costs	1	3	21	84	25	1	0

Quantitative Data

21. What is your capital expenditure for R&D as a percent of your R&D budget?
1989: 13.1% 1990: 15.4% 1991: 15.2%
22. R&D expenditures as percent of sales: 1990: 4.7%; anticipated for 1991: 4.7%
23. R&D professionals as a percent of total R&D personnel: 1990: 57%; anticipated for 1991: 57%
24. Operational costs per R&D professional**: for 1990: $158,500; estimate for 1991: $162,700

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* Research whose outcome may be unknown at the time the work is undertaken but where there's a reasonable expectation that findings will be valuable to the supporting organization.

** Refers to the actual cost of operating the laboratory. Numerator consists of such costs as salaries (professional and non-professional), fringe benefits, travel, training, supplies, secretarial, managerial, analytical and testing services in-house and outside, utilities, taxes, and depreciation. Denominator includes total number of professionals at the laboratory—technical and managerial.

Chapter 4

Science, Mathematics, and Technology Education and Human Resources in the FY1992 Budget

American Association for the Advancement of Science

Shirley M. Malcom

Preparing summary material on science, mathematics and technology (SMT) education and human resources in the analysis of the FY 1991 budget required extraordinary effort, time and persistence with programs scattered within and among agencies and departments. In contrast preparing the chapter for the FY 1992 budget was a simple and straightforward task, made easy by the months of work invested by the members (and their staffs) and staff of the Committee on Education and Human Resources (CEHR), Federal Coordinating Council for Science, Engineering and Technology (FCCSET) of the Office of Science and Technology Policy. "By the Year 2000: First in the World" was developed to present "a comprehensive baseline inventory of Federal funding and programs" that affect SMT education, and to establish "a set of strategic objectives and budget priorities to guide future Federal actions," according to D. Allan Bromley, OSTP Director and Special Assistant to the President for Science and Technology, in his letter of transmittal to the Congress. Special attention to SMT education among the education goals for the nation articulated by the President and the governors prompted this analysis. In undertaking this activity agencies moved to bring previously hidden initiatives "out of the closet," to seek expanded roles for education among their activities and even to obtain the legislative authority to add education to their missions. In its analysis FCCSET-CEHR distinguishes among the $1.94 billion of line item programs expressly appropriated and/or managed as SMT education funds, programs funded under research accounts which contribute to SMT education, and general education programs which provide some support to SMT education goals. Its report and this chapter focus primarily on programs in the first category which perforce underestimate the federal investment in SMT education.

Highlights

- Overall Federal funding request for precollege SMT education in FY 1992 is over $660 million, a 28.4 percent increase over anticipated FY 1991 spending for elementary secondary focused support. (This does not include some $2 billion of estimated Chapter 1 and Chapter 2 block grants that support SMT education goals.
- More than $477 million is requested for undergraduate SMT education in FY 1992, up more than 14 percent over enacted spending levels for FY 1991.
- Requested support for graduate SMT education totals some $803 million for FY 1992, an increase of only 2.4 percent over amounts enacted for FY 1991.

The National Science Foundation (NSF) and the Department of Education (ED) account for over 86 percent of all support for precollege science education, including over 99 percent of all federal funding for teacher preparation and enhancement. The Department of Education's Dwight D. Eisenhower Mathematics and Science State Grants Program is the largest single federal precollege SMT education program, providing block grants to states, and through them to localities and higher education to support teacher training. The program request of $239 million for FY 1992 exceeds by over 18 percent the program's FY 1991 spending level and represents a more than 88 percent increase in the program since FY 1990.

Between submission of FY 1991 and FY 1992 budgets the National Science Foundation underwent a reorganization, combining education functions previously located in the Directorate for Science and Engineering Education, and human resources functions previously located in its Directorate for Scientific, Technological and International Affairs, into the Directorate for Education and Human Resources. Human resources programs focus on addressing the special problems facing underrepresented groups in pursuing careers in science and engineering.

The NSF-EHR's FY 1992 budget request of $390 million repre-

Table 1. Support for Science, Mathematics and Technology Education at the National Science Foundation

Education and Human Resources	**FY 1990**	**FY 1991 Current Plan**	**FY 1992 Request**
Precollege			
Young Scholars	7.0	9.0	11.0
Networks	15.6	6.5	6.5
*Statewide Systemic Initiative	0	15.5	31.0
Teacher Preparation & Enhancement	62.6	93.7	97.3
Materials, Research & Informal	48.2	66	82
Presidential Teaching Awards	2.9	2.9	4.2
Studies, Evaluation & Dissemination	4.3	9.0	11.0
Minority Career Access	11.3	15.0	15.0
Undergraduate			
Instrumentation & Lab	15.8	23.0	23.0
Course and Curriculum	4.0	14.0	18.0
Faculty Enhancement	2.9	4.0	6.0
Graduate			
Fellowships	25.3	32.9	42.5
Minority Graduate Fellowships	4.5	6.0	7.5
Human Resource Development			
Visting Professorships for Women	2.26	2.75	2.75
Research Improvement in Minority Inst.	4.77	5.00	5.00
Minority Research Centers	5.83	8.00	8.00
Research Careers for Minority Scholars	3.47	6.60	6.60
Career Access (listed above)			
Alliances for Minority Participation	–	–	10.00
Faculty Awards for Women	–	2.5	2.65

*Funding for Statewide Systemic Initiative was supported through increased funding from Congress and reprogramming of funding previously directed at networks and partnerships.

sents a nearly 21 percent increase over the FY 1991 current plan of $322.32 million. An indication of the seriousness with which Congress views the problems of education and human resources lies in the fact that the FY 1991 current plan exceeds the FY 1991 request by $49 million; between FY 1990 and FY 1991 the budget for programs now encompassed by EHR increased 46 percent. Given the current mood of the Administration, the states and the Congress regarding the national needs in this area, the FY 1992 budget may be realized or even increase, even in an otherwise stringent budget environment.

While NSF and ED are the major players at the precollege level they are by no means the only agencies involved in support of SMT education. The FCCSET analysis has allowed a glimpse into the breadth of such support across the sixteen participating agencies and institutions of the federal government.

Requested support for undergraduate science, mathematics and engineering education in FY 1992 is $477 million, an increase of $60 million or 14 percent over FY 1991 figures. Department of Defense (DOD) provides the largest proportion of support at this level, nearly 37 percent, most in the form of direct student support. NSF provides over 27 percent, including the bulk of support for undergraduate faculty enhancement and curriculum development.

Through its pre- and postdoctoral fellowships and traineeships Health and Human Services (HHS) is the undisputed leader in graduate support, providing $421 million or over 52 percent of the $802.79 million available at this level. Graduate support accounts for nearly 46 percent of total SMT education expenditures anticipated in FY 1991 but only 41 percent of total SMT education request for FY 1992, representing a shift in budget emphasis toward the precollege level.

National Science Foundation (NSF)

In FY 1992 the National Science Foundation requests $456.09 million in support of science education at all levels. Some $390 million is requested for funding for the programs of the Directorate for Education and Human Resources (EHR). The NSF total included in the

FCCSET analysis consists of $371.6 million from EHR and $84.7 million from the research directorates mostly for undergraduate and graduate level activities. Over 55 percent of NSF education funds are directed at the precollege level, 29 percent at the undergraduate level and 16 percent at the graduate (and professional) level. For EHR funds these proportions are 65, 17.5 and 12.8 percent, respectively. Of course these figures vastly understate NSF support for graduate support because the definitions used in the FCCSET analysis exclude education support coincident to and included within the research function. The largest absolute increase between FY 1991 and FY 1992 is seen at the precollege level with a jump of more than $40 million. The largest percentage increase is at the undergraduate level. There the proposed $16 million increase represents a more than 30 percent increase since last fiscal year.

Within the precollege component teacher preparation and enhancement account for the lion's share of the investment. Some $139 million are carried within this subactivity, which includes teaching awards, networks and the new statewide systemic initiatives, in addition to the education and training activities from which the subactivity derives its name. The appearance of the state systemic initiatives represents an attempt by NSF to leverage systemwide change, taking a strategic proactive approach rather than a reactive approach, driven largely by initiatives from the field. The plan for 1992 calls for initiating ten new projects thereby doubling the number of active projects. Over 40 grants were received from the states for the FY 1991 solicitation, suggesting that the states are ripe for such a strategic focus. Materials development has been slated for an increase of $16 million largely to fund materials development in middle school and secondary school mathematics to support the curriculum standards.

NSF supports specific activities for underrepresented groups—minorities, women and people with disabilities. These targeted efforts are largely concentrated in Fellowships and in the Human Resource Development Subactivity of EHR. It should be noted, however, that every subprogram carries specific responsibility for addressing these issues, for example in meeting the needs of teachers in schools with high minority populations, in ensuring gender equity in materials produced or in providing accessibility to informal education programs.

Table 2. Support for Science Mathematics and Technology Education at the Department of Education (in millions)

Science, Mathematics and Technology	Fy 1990	FY 1991	FY 1992
Elementary and Secondary			
Eisenhower State Grants	126.8	202.0	239.0
Eisenhower Math/Science National	8.8	11.7	14.7
Star Schools	14.8	14.4	10.0
ERIC Sciencce, Math, Environment	0.3	0.3	0.4
Postsecondary			
Minority Science Improvement	5.4	5.9	6.1
National Sciene Scholars	_	1.0	10.0
Math/Science Achievement Award	_	_	40.0
Other Support Specified for SMT Education in FY 1992			
National Assessment of Educational Progress			14
National Diffusion Network			3.6
National R&D			20

Central to the Foundations's plan for a strategic approach to increasing minority participation in science and engineering is the Alliance for Minority Participation (AMP), a proposed decade long $10 million program to create broad based alliances dedicated to systemic improvement of undergraduate education for minorities, articulation across the undergraduate level to precollege and graduate, and increased minority degree production

Department of Education (ED)

Department of Education requests $29.1 billion for FY 1992, with $329.9 million in support of SMT education. Over 72 percent of SMT education funding is in the form of formula grants to the states largely to support teacher training. ED has proposed a new initiative as part of its Education Excellence Act, the Mathematics and Science Achievement Awards, $40 million in incentive grants to school districts which show the greatest improvement in performance on standardized tests of mathematics and science. A second new initiative, National Science Scholars, funded at $10 million in FY 1992, provides scholarships of up to $5000 per year for two students in each Congressional district.

FCCSET definitions limit the analysis of ED funds to those line items appropriated and/or managed. If the focus is shifted instead to opportunities for impact on SMT education, the analysis would include programs such as the Women's Educational Equity Act Program, Magnet Schools and ESEA Title I, Chapter I. Chapter I, with a 1991 appropriation and FY 1992 request of over $6 billion, includes a significant level of support for SMT education for disadvantaged children.

An increase of funding for the National Assessment will permit testing in mathematics to provide State-by-State comparisons at the 4th and 8th grades in 1992.

Department of Agriculture (USDA)

Of the $21.6 million requested for FY 1992, most supports programs at the undergraduate and graduate levels. Included in this request is an $11 million capacity building program targeted at 1890 land grant institutions and Tuskegee University (Historically Black Colleges and Universities) to strengthen their programs in food and agricultural sciences. Not counted in this analysis is the more than $ 42 million in support of 4-H, a youth serving organization providing informal experiential education to some 2.8 million youth.

Department of Commerce (DOC)

The department requests $7.6 million for education programs, over $5 million of which are focused at the graduate level, including a $3.35 million request to support 45 post-doctoral fellowships through the National Institute of Standards and Technology research associateships program.

Table 3. FCCSET Committee on Education and Human Resources, FY 1992 Budget Matrix
Funding by Agencies by Educational Level (in millions)

	Precollege	Undergraduate	Graduate	Total
NSF	253.05	132.32	70.72	456.09
ED	313.8	16.10	00.00	329.9
DOE	21.65	30.18	22.60	74.43
DOD	4.97	176.08	234.80	415.85
DOC	0.55	1.90	5.15	7.60
NASA	14.10	25.03	28.02	67.15
DOI	21.96	8.83	10.92	41.71
HHS	21.77	70.14	421.18	513.09
EPA	8.07	4.30	1.00	13.37
USDA	0.70	12.50	8.40	21.60
Total	660.62	477.38	802.79	1940.79

Department of Defense (DOD)

The bulk of the $415.85 million request for DOD is concentrated at the graduate level, $234.8 million for FY 1992. DOD, with $176 million, leads all agencies in its support for undergraduate programs, mostly for support of approximately 13,000 science, mathematics and engineering majors in Reserve Officer Training Corps ($100.5 million).

Department of Energy (DOE)

DOE continues to expand its role in education, The FY 1992 request of $74.43 million includes $21.65 million for precollege programs, mostly in informal education, $30.08 million in undergraduate programs and $22.6 million in graduate programs. This total request represents a 16 percent increase over 1991 funding. Much of the support is in the form of lab-based initiatives, especially in programs for students and teachers and alliances with minority institutions.

Department of Health and Human Services (HHS)

Of the $513 million requested in FY 1992 $421.18 million or 82 percent supports a traditional HHS focus on graduate training and career enhancement in biomedical and health related fields. Much of the $70.1 million (13.5 percent of education total) budgeted at the undergraduate level is targeted toward programs to increase minority participation in biomedical fields through efforts such as the NIH Minority Access to Research Careers (MARC) with a requested funding level of $15 million and the Minority Biomedical Research Support (MBRS) program. MBRS, which involves students at institutions with significant minority student enrollments in biomedical research, is requesting $33.2 million in FY 1992, an increase of around 5 percent. This represents essentially level funding for this NIH program. Another $10–12 million has been available to support MBRS through co-funding arrangements with other institutes.

Department of Interior (DOI)

Most of the $41.71 million request for FY 1992 supports precollege efforts, much of it in workshops, informal classes and student employment programs. Undergraduate programs of some $8.8 million are scattered across the various bureaus and divisions, supporting activities such as employment and curriculum enhancement to increase minority and disadvantaged student participation in earth sciences education and careers. Not counted in Interior's figures are the approximately $75 million estimated for SMT education in Bureau of Indian Affairs programs and support provided to the extensive educational and interpretive activities of the Park Service.

Environmental Protection Agency (EPA)

With the passage of the National Environmental Education Act $7 million of the EPA's FY 1992 $13.37 million budget for education is requested for a new precollege environmental education initiative focused largely on informal, public awareness efforts.

National Aeronautics and Space Administration (NASA)

Some $28 million of its $67 million request for FY 1992 education programs is targeted at the graduate level, largely through its Graduate Student Researchers and Resident Research Associateships programs providing predoctoral and post-doctoral fellowships, respectively, supporting aerospace research largely at NASA centers. Some $14 million for FY 1992 is targeted at the precollege level, mostly through a variety of informal education programs in aerospace education.

Underrepresented Groups

Support for underrepresented groups is distributed throughout the federal budget in a set of targeted programs. In the Department of Agriculture this takes the form of institution focused capacity building grants to HBCU's. Within the Department of Commerce support is mostly for small local programs largely targeted at minority students.

Department of Defense programs range from programs of support for specific local precollege initiatives, to funding for HBCU's and postdoctoral fellowships for women through the office of Naval Research's Women Science Scholars Program. DOD has had a significant research apprenticeship program since this program was initiated government-wide in the early 1980's.

Support for underrepresented groups in the Department of Education includes the $6.1 million FY 1992 request for the Minority Science Improvement Program. Not included in the FCCSET analysis was ED's program of graduate support for women and minorities in fields in which they are underrepesented.

The largest complement of targeted programs are present in the Department of Health and Human Services (see discussion above of MARC and MBRS programs) and within the National Science Foundation.

Department of Energy has signalled its interest in underrepresented groups through its lab initiated efforts as well as within its national initiatives. Direct programs for students and faculty as well as institution based programs have been developed as a part of DOE's response to underparticipation especially minority students.

The Bottom Line

While dollars are scattered across the landscape of programs a coherent federal wide strategy for underrepresented groups has yet to be articulated. The FCCSET-CEHR exercise represents an important first step toward developing such a strategy, however.

Cross agency coordination of precollege funding coupled with effective leveraging of state and local dollars represent the single best hope of realizing the goal articulated in the title of FCCSET-CEHR's ambitions report, "By the Year 2000: First in the World."

FY 1992 BUDGET FOR SMT EDUCATION BY AGENCY AND MAJOR PROGRAM AREA (IN MILLIONS) (FROM FCCSET-CEHR ANALYSIS)

MAJOR CATEGORIES	Total Request	NSF	ED	DOE	DOD	DOC	NASA	DOI	HHS	EPA	USDA
GRAND TOTAL	1940.79	456.09	329.90	74.43	415.85	7.60	67.15	41.71	513.09	13.37	21.60
Precollege Total	660.62	253.05	313.80	21.65	4.97	0.55	14.10	21.96	21.77	8.07	0.70
Teacher Preparation/Enhancement	358.53	97.30	239.00	6.20	0.63	0.25	5.57	2.06	5.15	2.37	0.00
Curriculum Development*	137.27	84.75	34.80	1.90	0.00	0.09	5.60	3.60	4.52	2.01	0.00
Comprehensive/Organizational Reform	57.57	47.55	0.00	6.40	0.00	0.00	0.28	0.50	0.60	2.04	0.20
Student Incentives	47.75	11.00	0.00	5.75	4.34	0.21	0.55	14.32	10.87	0.21	0.50
Other	59.50	12.45	40.00	1.40	0.00	0.00	2.10	1.49	0.62	1.44	0.00
Undergraduate Total	477.38	132.32	16.10	30.18	176.08	1.90	25.03	8.84	70.14	4.30	12.50
Faculty Preparation/Enhancement	42.36	27.55	0.00	2.40	0.00	0.00	9.65	1.84	0.02	0.90	0.00
Curriculum Development*	123.66	63.66	6.10	11.60	38.90	0.20	1.81	1.12	0.19	0.10	0.00
Comprehensive	47.65	14.95	0.00	3.85	6.80	0.00	1.68	0.53	6.34	1.00	12.50
Student Incentives	230.27	24.81	10.00	12.33	100.50	1.70	11.73	4.30	62.59	2.30	0.00
Other	33.44	1.35	0.00	0.00	29.88	0.00	0.16	1.05	1.00	0.00	0.00
Graduate Total	802.79	70.72	0.00	22.60	234.80	5.15	28.02	10.92	421.17	1.00	8.40
Predoctoral Fellowships	100.53	51.52	0.00	10.04	16.70	.085	13.80	0.03	6.79	0.80	0.00
Predoctoral Traineeships	153.85	4.40	0.00	0.00	3.90	0.00	4.70	10.41	126.44	0.00	4.00
Postodctoral Fellowships	100.08	9.85	0.00	10.05	10.50	3.35	9.10	0.48	52.15	0.20	4.40
Postdoctoral Traineeships	157.57	4.00	0.00	0.00	0.00	0.00	0.00	0.00	153.57	0.00	0.00
Other*	290.75	0.95	0.00	2.51	203.70	0.95	0.42	0.00	82.22	0.00	0.00

*includes program assessment and evaluation

Overview Tables

Table I-1. Composition of the FY 1992 Budget (outlays in billions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Current Dollars				
National Defense	$299.3	$298.9	$295.2	-1.2%
R&D Included	(41.6)	(39.8)	(42.4)	6.4%
Payments and Grants[1]	641.8	713.3	765.2	7.3%
Net Interest	184.2	197.0	206.3	4.7%
Undistributed Offsetting Receipts	-36.6	-39.1	-40.8	4.3%
Other Government	163.0	239.4	219.9	-8.1%
R&D Included	(23.7)	(27.0)	(29.2)	8.2%
TOTAL Outlays	$1,251.7	$1,409.6	$1,445.9	2.6%
R&D Included	(65.3)	(66.8)	(71.6)	7.2%
Receipts	$1,031.3	$1,091.4	$1,165.0	6.7%
Deficit (-) or Surplus	-$220.4	-$318.1	-$280.9	11.7%
Constant FY 1982 Dollars				
National Defense	$247.0	$235.9	$223.3	-5.3%
R&D Included	(31.7)	(29.1)	(29.7)	2.1%
Payments and Grants[1]	472.0	496.1	510.8	3.0%
Net Interest	139.8	143.2	144.0	0.6%
Undistributed Offsetting Receipts	-27.3	-27.9	-28.0	0.4%
Other Government	124.1	173.9	154.0	-11.4%
R&D Included	(17.7)	(19.3)	(20.0)	3.6%
Total Outlays	$955.5	$1,021.1	$1,004.2	-1.7%
R&D Included	(49.4)	(48.4)	(49.7)	2.7%
Receipts	$787.3	$790.7	$809.1	2.3%
Deficit (-) or Surplus	-$168.2	-$230.5	-$195.1	15.4%

Source: *Budget of the United States Government, Fiscal Year 1992.*

[1] Payments to individuals and grants-in-aid.

Table I-2. Projections Through FY 1996 in the FY1992 Budget (outlays in billions)

	FY 1992 Budget	FY 1993 Projected	FY 1994 Projected	FY 1995 Projected	FY 1996 Projected
Current Dollars					
National Defense	$295.2	$292.0	$286.7	$288.6	$293.2
R&D Included	(41.6)	(41.2)	(40.4)	(40.7)	(41.3)
Payments and Grants[1]	765.2	814.4	870.3	925.0	979.9
Net Interest	206.3	212.0	215.5	213.8	211.0
Undistributed Offsetting Receipts	-40.8	-43.7	-41.4	-44.8	-44.9
Other Government	219.9	179.5	96.1	87.6	101.6
R&D Included	(29.2)	(29.1)	(28.5)	(29.5)	(31.2)
TOTAL Outlays	$1,445.9	$1,454.2	$1,427.1	$1,470.3	$1,540.8
Receipts	$1,165.0	$1,252.7	$1,365.3	$1,467.3	$1,560.7
Deficit (-) or Surplus	-$280.9	-$201.5	-$61.8	-$2.9	$19.9
Constant FY 1982 Dollars					
National Defense	$223.3	$212.0	$201.1	$196.0	$192.9
R&D Included	(29.7)	(28.2)	(26.7)	(26.1)	(25.7)
Payments and Grants[1]	510.8	523.4	539.5	553.7	567.1
Net Interest	144.0	142.7	140.0	134.2	128.1
Undistributed Offsetting Receipts	-28.0	-28.9	-26.5	-27.6	-26.8
Other Government	154.0	122.3	65.1	57.9	64.6
R&D Included	(20.0)	(19.5)	(18.7)	(18.7)	(19.1)
TOTAL Outlays	$1,004.2	$971.4	$919.3	$914.3	$925.9
Receipts	$809.1	$836.8	$879.5	$912.5	$937.8
Deficit (-) or Surplus	-$195.1	-$134.6	-$39.8	-$1.8	$12.8

Source: *Budget of the United States Government, FY 1992.* Constant FY 1982 dollars based on OMB fiscal year deflators for defense R&D and nondefense R&D.

[1] Payments to individuals and grants-in-aid.

Table I-3. Budget Authority, Obligations, and Outlays for R&D, Including Facilities (in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92
Defense R&D				
Budget Authority	$40,978.3	$39,721.5	$44,495.0	12.0%
Obligations	42,283.1	38,849.2	44,090.8	13.5%
Outlays	41,580.8	39,820.3	42,378.5	6.4%
Nondefense R&D				
Budget Authority	25,467.3	28,351.5	31,053.2	9.5%
Obligations	25,012.6	29,643.9	31,223.9	5.3%
Outlays	23,742.1	26,951.2	29,171.9	8.2%
Total R&D				
Budget Authority	66,445.6	68,073.0	75,548.2	11.0%
Obligations	67,300.7	68,493.1	75,314.7	10.0%
Outlays	65,322.9	66,771.5	71,550.4	7.2%
Constant FY 1982 Dollars (Budget Authority only)				
Defense R&D	$31,238.2	$29,004.4	$31,211.4	7.6%
Nondefense R&D	18,971.5	20,226.5	21,279.5	5.2%
TOTAL R&D	$50,209.7	$49,230.9	$52,490.9	6.6%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justifications. Constant 1982 dollars based on OMB fiscal year implicit price deflators for national defense R&D and nondefense R&D.

Table I-4. Major Components of Federal Funding for R&D[1] (budget authority in billions)

	FY 1967 Actual	FY 1972 Actual	FY 1989 Actual	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget
Current Dollars						
Defense[2]	$8.8	$9.2	$41.6	$41.0	$39.7	44.5
Nondefense[3]	8.3	7.9	22.7	25.5	28.4	31.1
Space[4]	4.7	2.7	3.7	4.7	5.2	6.0
Health[5]	1.3	2.0	8.2	8.9	9.8	10.3
Energy[6]	0.6	0.6	2.5	3.0	3.2	3.1
General Science[7]	0.5	0.7	2.7	2.8	3.1	3.8
All Other[7]	1.2	1.9	5.7	6.1	7.1	7.9
TOTAL R&D	$17.1	$17.1	$64.4	$66.4	$68.1	$75.5
Constant FY 1982 Dollars						
Defense	$31.3	$23.0	$33.0	$31.3	28.7	$31.2
Nondefense	29.7	19.8	17.7	18.9	20.6	21.3
Space	16.8	6.8	2.9	3.5	3.7	4.1
Health	4.7	5.0	6.4	6.6	7.0	7.1
Energy	2.1	1.5	1.9	2.5	2.4	2.5
General Science	1.8	1.8	2.1	2.1	2.2	2.6
All Other	4.3	4.8	4.4	4.2	5.3	5.0
TOTAL R&D	$61.0	$42.8	$50.7	$50.2	$49.3	$52.5

Source: Based on OMB's data for R&D analysis for FY 1992 and agency budget justifications. Constant 1982 dollars based on OMB fiscal year deflators for defense R&D and nondefense R&D.

[1] Includes conduct of R&D and R&D facilities.

[2] Includes DOD and defense activities of DOE.

[3] Includes all R&D not in defense.

[4] Reflects totals for NASA R&D less space applications and aeronautics.

[5] Includes health research in HHS, VA, Education and EPA. FY 1967 and 1972 based on OMB data for health research in all federal agencies.

[6] Includes NRC, EPA energy research, and DOE less defense activities and general science.

[7] Includes NSF and DOE general science.

Table I-5. R&D by Character of Work (budget authority in billions)

	FY 1967 Actual	FY 1972 Actual	FY 1989 Actual	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget
Current Dollars						
Basic Research	$1.8	$2.2	$10.6	$11.3	$12.5	$13.3
Applied Research	2.9	3.6	9.8	10.2	11.5	12.4
TOTAL Research	$4.7	$5.8	$20.4	$21.5	$24.0	$25.7
Development	11.8	10.7	41.6	42.3	41.0	46.3
TOTAL Conduct of R&D	$16.5	$16.5	$62.0	$63.8	$65.0	$72.0
R&D Facilities	0.6	0.6	2.3	2.6	3.1	3.5
TOTAL R&D	$17.1	$17.1	$64.3	$66.4	$68.1	$75.5
Constant FY 1982 Dollars						
Basic Research	$6.4	$5.5	$8.4	$8.5	$9.0	$9.2
Applied Research	10.4	9.0	7.7	7.7	8.3	8.6
TOTAL Research	$16.8	$14.5	$16.1	$16.3	$17.4	$17.9
Development	42.1	26.8	32.8	32.0	29.7	32.2
TOTAL Conduct of R&D	$58.9	$41.3	$48.9	$48.2	$47.1	$50.1
R&D Facilities	2.1	1.5	$1.8	2.0	2.2	2.4
TOTAL R&D	$61.0	$42.8	$50.7	$50.2	$49.3	$52.5

Source: OMB's data for R&D analysis for FY 1992, agency budget justifications, and National Science Foundation, *Federal Funds for Research and Development*, Vol. 39. Constant 1982 dollars based on OMB fiscal year deflators.

Table I-6. Defense and Nondefense R&D by Character of Work (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92	
				Current $	Constant $
Basic Research					
Defense	$963.8	$1,200.2	$1,041.0	-13.3%	-16.7%
Nondefense	10,314.9	11,298.4	12,[illegible]65.2	8.6%	4.3%
TOTAL	$11,278.7	$12,498.6	$13,306.2	6.5%	2.2%
Applied Research					
Defense	$2,818.5	$3,148.0	$3,350.1	6.4%	2.2%
Nondefense	7,378.4	8,358.3	9,064.8	8.5%	4.2%
TOTAL	$10,196.9	$11,506.3	$12,414.9	7.9%	3.6%
Development					
Defense	$36,151.9	$34,325.8	$38,850.9	13.2%	8.7%
Nondefense	6,175.3	6,679.2	7,454.0	11.6%	7.2%
TOTAL	$42,327.3	$41,005.0	$46,304.9	12.9%	8.5%
TOTAL Conduct of R&D					
Defense	$39,934.2	$38,674.0	$43,242.0	11.8%	7.4%
Nondefense	23,868.6	26,335.9	28,784.0	9.3%	5.0%
TOTAL	$63,802.9	$65,009.9	$72,026.0	10.8%	6.4%
R&D Facilities					
Defense	$1,044.0	$1,047.5	$1,253.0	19.6%	14.9%
Nondefense	1,598.7	2,015.6	2,269.2	12.6%	8.1%
TOTAL R&D Facilities	$2,642.7	$3,063.1	$3,522.2	15.0%	10.4%

Table I-6. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92	
				Current $	Constant $
TOTAL R&D					
Defense R&D	$40,978.3	$39,721.5	$44,495.0	12.0%	7.6%
Nondefense R&D	25,467.3	28,351.5	31,053.2	9.5%	5.2%
TOTAL R&D	$66,445.6	$68,073.0	$75,548.2	11.0%	6.6%

Source: OMB's data for R&D analysis for FY 1992. Constant 1982 dollars based on OMB fiscal year deflators for defense R&D and nondefense R&D.

Table I-7. R&D in Selected Agencies (budget authority in millions)[1]

	FY 1990 Actual	FY 1991 Estimate	FY 1991 Budget	Percent Change FY 1991-92	
				Current $	Constant $
Department of Defense	$37,869.1	$36,527.3	$41,012.3	12.3%	7.9%
Department of Energy-Defense	3,109.2	3,194.2	3,482.7	9.0%	4.7%
TOTAL Defense	(40,978.3)	(39,721.5)	(44,495.0)	12.0%	7.6%
Department of Energy-General Science	1,078.0	1,137.7	1,531.5	34.6%	29.3%
Department of Energy-Energy	2,850.7	3,028.3	2,975.2	-1.8%	-5.6%
TOTAL DOE	(7,037.9)	(7,360.2)	(7,989.4)	8.5%	4.3%
National Aeronautics and Space Administration	7,111.6	8,127.9	9,486.7	16.7%	12.1%
National Science Foundation	1,728.8	1,920.2	2,241.9	16.7%	12.1%
National Institutes of Health	7,215.3	7,889.3	8,372.9	6.1%	1.9%
Other Health and Human Services	1,317.6	1,566.1	1,588.8	1.4%	-2.6%
Department of Agriculture	1,223.3	1,379.9	1,389.8	0.7%	-3.3%
Environmental Protection Agency	424.2	452.0	491.3	8.7%	4.4%
Department of Education	163.3	199.7	219.4	9.9%	5.5%
National Oceanic and Atmospheric Administration	301.9	343.8	341.1	-0.8%	-4.7%
National Institute of Standards and Technology	134.9	175.5	204.7	16.6%	12.0%
Geological Survey	309.7	354.6	340.8	-3.9%	-7.7%
Bureau of Mines	101.0	109.0	82.7	-24.1%	-27.1%
All Other	1,507.0	1,667.5	1,786.4	7.1%	2.9%
TOTAL Nondefense	(25,467.3)	(28,351.5)	(31,053.2)	9.5%	5.2%
TOTAL R&D	$66,445.6	$68,073.0	$75,548.2	11.0%	6.6%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justifications.

[1] Includes conduct of R&D and R&D facilities.

Table I-8. Conduct of Basic Research by Agency in Current Dollars (budget authority in millions)

	FY 1982 Actual	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92	
					Current $	Constant $
Health and Human Services	$1,954.0	$4,659.0	$5,099.1	$5,474.5	7.4%	3.1%
National Institutes of Health	(1,841.0)	(4,252.1)	(4,633.8)	(4,967.9)	7.2%	3.0%
National Science Foundation	913.0	1,569.2	1,719.0	1,987.0	15.6%	11.0%
Defense (Military)	696.0	936.1	1,169.0	1,009.8	-13.6%	-17.0%
Energy	779.0	1,510.2	1,729.8	1,747.4	1.0%	-3.0%
National Aeronautics & Space Administration	536.0	1,630.8	1,697.7	1,960.1	15.5%	10.9%
Agriculture	334.0	517.0	562.6	598.1	6.3%	2.1%
Interior	74.0	206.2	229.6	207.5	-9.6%	-13.2%
Smithsonian	56.0	95.0	106.0	112.0	5.7%	1.5%
Commerce	17.0	30.6	31.2	34.1	9.3%	5.0%
Veterans Affairs	13.0	16.2	15.8	15.8	0.0%	-3.9%
Education	16.0	4.5	7.0	8.6	22.9%	18.0%
Environmental Protection Agency	24.0	74.5	98.0	116.0	18.4%	13.7%
Agency for International Development[1]	—	4.3	9.3	10.2	9.7%	5.3%
Other	31.0	25.1	24.5	25.1	2.4%	-1.6%
TOTAL, Basic Research	$5,440.0	$11,278.7	$12,498.6	$13,306.2	6.5%	—
TOTAL, Basic Research (Constant FY 1982 $)	$5,440.0	$8,528.3	$9,045.8	$9,248.8	—	2.2%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justifications.

[1] Reported under "Other" in 1982.

Table I-9. Estimated Support for Conduct of R&D at Colleges and Universities in Current Dollars (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92	
				Current $	Constant $
Health and Human Services	$4,894.1	$5,311.7	$5,671.5	6.8%	2.6%
National Institutes of Health	(4,187.2)	(4,505.2)	(4,813.1)	6.8%	2.6%
National Science Foundation	1,238.6	1,356.0	1,565.0	15.4%	10.9%
Defense (military)	1,129.8	1,234.4	1,075.2	-12.9%	-16.3%
Agriculture	330.3	381.5	381.1	-0.1%	-4.0%
Energy	538.1	640.7	564.9	-11.8%	-15.3%
National Aeronautics and Space Administration	493.0	533.0	600.0	12.6%	8.1%
Agency for International Development	47.2	36.8	33.6	-8.7%	-12.3%
Environmental Protection Agency	75.6	68.6	68.6	0.0%	-3.9%
Education	103.5	124.8	140.5	12.6%	8.1%
Interior	45.9	57.0	39.2	-31.2%	-33.9%
Transportation	27.6	26.6	25.0	-6.0%	-9.7%
Commerce	51.0	52.9	76.2	44.0%	38.4%
Other	21.5	22.0	26.8	21.8%	17.0%
TOTAL, Current Dollars	$8,996.2	$9,846.0	$10,267.6	4.3%	–
TOTAL, Constant 1982 Dollars	$6,802.4	$7,126.0	$7,136.7	–	0.2%

Source: OMB's data for R&D analysis for FY 1992. Constant 1982 dollars based on OMB fiscal year deflators for defense R&D and nondefense R&D.

Table I-10. National Pattern of R&D: Estimated 1991 Expenditures and 2-Year Constant Dollar Changes, 1989-91 (in millions)

	Sources of Funds				
Performers of R&D	Federal Government	Industry	Colleges & Universities	Non-profit Institutions	Total Funds for R&D
Estimated 1991 Expenditures					
Federal Government	$16,400	$0	$0	$0	$16,400
Industry	32,300	76,150	0	0	108,450
Colleges and Universities	9,650	1,250	4,950	1,350	17,200
Federally Funded R&D Centers	4,850	0	0	0	4,850
Non-profit Institutions	2,800	650	0	1,250	4,700
TOTAL, All R&D Performers	$66,000	$78,050	$4,950	$2,600	$151,600
2-Year Percent Change in 1982 Constant Dollars (1989-91)					
Federal Government	0.1%	0.0%	0.0%	0.0%	-0.1%
Industry	5.2%	3.0%	0.0%	0.0%	-1.8%
Colleges and Universities	-1.0%	16.8%	15.4%	14.8%	5.6%
Federally Funded R&D Centers	-6.3%	0.0%	0.0%	0.0%	-6.3%
Non-profit Institutions	3.1%	8.6%	0.0%	15.1%	6.8%
TOTAL, All R&D Performers	-3.1%	0.0%	15.4%	14.9%	-7.0%

Source: National Science Foundation SRS, unpublished data. Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D in the budget elsewhere in this report. Capital expenditures for R&D are generally excluded.

Table I-11. National Funds for R&D by Source of Funds (in millions)

	FY 1975 Actual	FY 1980 Actual	FY 1989 Actual	FY 1990 Estimate	FY 1991 Estimate
Current Dollars					
Federal Government	$18,109	$29,453	$62,688	$64,000	$66,000
Industry	15,820	30,913	71,767	74,700	78,050
Colleges and Universities	749	1,318	3,948	4,450	4,950
Non-profit Institutions	535	909	2,803	2,300	2,600
TOTAL	$35,213	$62,593	$141,206	$145,450	$151,600
Constant FY 1982 Dollars					
Federal Government	$30,986	$34,548	$49,553	$48,591	$47,991
Industry	26,679	36,066	56,815	56,757	56,799
Colleges and Universities	1,302	1,555	3,115	3,376	3,596
Non-profit Institutions	916	1,066	1,646	1,746	1,890
TOTAL	$59,883	$73,235	$111,129	$110,470	$110,276
TOTAL R&D as percent of GNP	2.2%	2.3%	2.7%	2.7%	2.7%

Source: National Science Foundation, SRS, unpublished data and *Budget of the United States Government, Fiscal Year 1992.*
Amounts represent current R&D operating costs based on data from performers of R&D and therefore do not correspond to the figures for R&D in the budget elsewhere in this report. Capital expenditures for R&D are generally excluded.

Table I-12. National Funds for R&D by Performers of R&D (in millions)

	FY 1975 Actual	FY 1980 Actual	FY 1989 Actual	FY 1990 Estimate	FY 1991 Estimate
Current Dollars					
Federal Government	$5,354	$7,632	$15,121	$16,100	$16,400
Industry	24,187	44,505	101,599	104,200	108,450
Colleges and Universities	3,409	6,060	14,987	16,000	17,200
Federally Funded R&D Centers	987	2,246	4,729	4,800	4,850
Non-profit institutions	1,276	2,150	4,050	4,350	4,700
TOTAL	$35,213	$62,593	$140,486	$145,450	$151,600
Constant FY 1982 Dollars					
Federal Government	$9,308	$9,006	$11,931	$12,213	$11,914
Industry	40,781	51,919	80,436	79,173	78,924
Colleges and Universities	5,927	7,151	11,825	12,137	12,495
Federally Funded R&D Centers	1,716	2,650	3,731	3,641	3,523
Non-profit institutions	2,151	2,508	3,206	3,305	3,420
TOTAL	$59,883	$73,234	$111,129	$110,469	$110,276
TOTAL R&D as percent of GNP	2.2%	2.3%	2.7%	2.7%	2.7%

Source: National Science Foundation, SRS, unpublished data. Amounts represent current R&D operating costs based on data from performers of R&D and therefore do not correspond to the figures for R&D in the budget elsewhere in this report. Capital expenditures for R&D are generally excluded.

Table I-13. Industry Spending for R&D by *Business Week* Groupings, 1989 (in millions)

Industry	1989	Percent Change from 1988
Aerospace	$3,936.7	2%
Automotive	10,284.4	9%
Chemicals	4,752.9	8%
Conglomerates	3,448.4	10%
Consumer Products	1,678.0	11%
Containers and Packaging	91.3	0%
Electrical and Electronics	6,493.0	9%
Electrical Products	689.2	7%
Electronics	2,216.9	12%
Instruments	1,431.8	2%
Semiconductors	2,155.1	10%
Food	495.8	8%
Fuel	2,479.7	7%
Health Care	7,125.8	13%
Drugs and Research	5,143.6	14%
Medical Products and Services	1,982.1	9%
Housing and Construction	463.8	4%
Leisure Time Industries	1,714.0	7%
Manufacturing	2,796.2	13%
Metals and Mining	293.1	7%
Nonbank Financial	84.9	22%
Office Equipment and Computers	15,248.1	17%
Business Machines and Services	267.7	8%
Computer Communications	304.6	27%
Computers	11,736.5	17%
Data Processing	177.4	22%
Disk and Tape Drives	365.3	21%
Peripherals and Other Devices	973.5	1%
Software and Services	819.6	40%
System Design	603.6	14%
Paper and Forest Products	432.3	3%
Publishing and Broadcasting	3.3	31%
Service Industries	142.4	3%
Telecommunications	3,304.0	3%
TOTAL	$65,231.0	10%

Source: *Business Week,* "R&D Scoreboard, 1989," June 15, 1990. Reprinted by permission, © 1990.

Note: Based on SEC data for companies reporting 1989 sales of $35 million or more, and R&D expenses amounting to at least $1.0 million or at least 1.0 percent of sales.

Part II: Agency R&D Budgets

Introduction

In this section, R&D in the federal budget is examined through the agencies that support and perform the work. Separate chapters examine the R&D activities of the principal R&D agencies. These are followed by budget tables, starting with a summary table of R&D budget totals by agency from FY 1990 to FY 1992 and followed by detailed budget tables for each major agency, to support discussions of the Bush Administration's programs and policies for R&D.

The discussions of agency R&D programs assess budget trends and policy choices reflected in the FY 1992 budget in as detailed a manner as possible. Some agencies have been treated in greater depth than others, reflecting differences in availability of information or issues of special importance. Aspects of certain important agency R&D budgets which do not appear in this section may be found in the disciplinary analyses in Part III. For instance, although there is no chapter devoted to NOAA in this section, a discussion of its programs is contained in Chapter 14, "FY 1992 R&D in the Atmospheric and Oceanic Sciences."

Budget figures in the detailed agency tables may not correspond exactly to the amounts in the summary tables here and elsewhere in the report. The data in the summary tables were generally prepared based on OMB and NSF data, while the agency tables were derived using agency budget justifications. R&D is often not managed or budgeted by the agencies in categories which correspond exactly to those used by OMB and NSF for statistical purposes. Where significant differences have been found, they are discussed in footnotes to the agency tables.

Where trends in constant dollars are shown, our calculations are based on the fiscal year deflators developed by OMB to reflect differences in rates of inflation in defense and nondefense R&D costs.

Agency Summary

The composition by agency of the totals for conduct of R&D and R&D facilities is shown in Table II-1. The numbers are drawn directly from the budget authority data compiled by OMB for their analysis of the FY 1992 budget.

The last column of the table shows the percentage change in constant dollars from FY 1991-92 — "real" dollar figures, intended to reflect trends in the purchasing power of agency R&D allocations. These figures highlight several trends discussed in detail in the sections which follow.

Chapter 5

R&D in the FY 1992 Department of Defense Budget

American Association for the Advancement of Science

Paul R. Gehman, Jr., Albert H. Teich

The Defense Budget and the Defense Environment

President Bush's FY 1992 budget request represents the first year in the Administration's five-year plan to restructure America's armed forces in response to recent political developments in Europe and the Soviet Union, to arms limitation treaties (enacted or in negotiation), and to domestic budget constraints. This restructuring will have many implications for defense RDT&E.

The nation's force structure will be scaled down. There will be reductions in the number of Army divisions, the number of battle force ships in the Navy, and the number of Air Force tactical fighter wings and strategic bombers. High levels of readiness will be maintained, but with lower levels of military manpower, both in active units and reserves. Current acquisition programs will be stretched out, scaled down or canceled. Future acquisition programs will be fewer in number. As Secretary of Defense Cheney recently told Congress, the overall acquisition approach for the 1990s will differ markedly from the 1980s — this will be a "decade of development, more than of production."

Topline Highlights

- The defense budget is shrinking. President Bush's FY 1992 budget includes $278.3 billion in budget authority and $283 billion in outlays for DOD This represents a 1 percent real decrease in budget authority compared to FY 1991.

- The defense budget will continue to shrink over the next several years. In current dollars, the projected FY 1995 budget allocates $280.7 billion in budget authority and $274.6 in outlays for DOD. Adjusted for inflation, budget authority levels will record declines of 3.9 percent in FY 1993, 3.6 percent in FY 1994, and 2.7 percent in FY 1995.

- Within the shrinking defense budget, however, RDT&E will grow. The Administration's proposal for FY 1992 allocates $41.0 billion in budget authority for defense RDT&E. This is an increase of nearly $4.5 billion, or 12.3 percent, over the prior year's funding level. (See Table II-2.)

- Spending for technology base programs is slated to decline slightly from the FY 1991 appropriated level, which included nearly $500 million in congressional add-ons. The Administration's proposal allocates about $3.9 billion for technology base, slightly less than a 1 percent decrease from FY 1991 (Table II-2).

- Most of the growth in defense RDT&E will be in development, testing, and evaluation. The Administration's proposal provides $36.6 billion for these activities, representing a 13.8 percent increase (Table II-4). Large increases are in order for advanced technology development (37.2 percent), strategic development (21.0 percent), intelligence and communication development (15.9 percent), while more modest increases are requested for tactical development (5.6 percent) and defense-wide development (5.6 percent).

- After several years of shrinking budgets, the Strategic Defense Initiative (SDI) is slated to expand. The budget allocates just over $5.15 billion to SDI, a huge increase over last year's $2.86 billion appropriation. Congress severely cut SDI funding last year. However, during the past twelve months, the Bush Administration has refocused the SDI program toward providing global protection from limited ballistic missile strikes.

- The newly created (and congressionally mandated) Tactical Missile Defense Initiative is set to expand. TMDI, which received $218.2 million last year, is allocated $508.0 million in the FY 1992 budget, primarily to accelerate the demonstration and validation of theater/tactical ballistic missile defenses. A total of $70.0 million is requested for full scale development of TMDI.

The Defense Environment: External Threats

The events of August 2, 1990 seem to have put an end to discussions of the elusive peace dividend. Instead, the Persian Gulf has commanded the attention of policymakers and the public around the world. Following an unsuccessful search for a peaceful resolution to crisis precipitated by Iraq's invasion of Kuwait, United Nations forces, led by the United States, attacked Iraq on January 17, 1991, initially by air and subsequently (February 23) on the ground.

Weapons systems that were developed and purchased in the 1980s with much different military scenarios in mind found their first battlefield tests in the Gulf War. The information gathered and knowledge gained from this war will be utilized to evaluate these systems and future proposals.

Recent media reports highlight the new "science of war." Radar evading F-117A Stealth fighters deliver laser guided munitions. TV-guided "smart" bombs, anti-radar missiles, infrared cluster bombs, daisy cutter bombs, and runway cratering bombs are also delivered by aircraft. Submarines and ships have launched hundreds of Tomahawk cruise missiles against Iraqi targets. On the ground, the all-climate main battle tank supports the combination of thermal sight, laser rangefinder, and stabilized smoothbore cannon. In close battlefield support, Apache helicopters deliver laser homing anti-armor Hellfire missiles, while A-10 Thunderbolt aircraft deliver Maverick antitank missiles.

The technological hero of the war (at least in the popular media) has certainly been the Patriot missile. Originally designed to defend against aircraft, the Patriot was upgraded into an anti-missile system with proximity interception. Hit-to-kill capabilities are the logical next step. The success of the current system has been against Iraqi launched Scud missiles -- relatively slow and inaccurate devices with limited range, usually armed with small conventional payloads and aimed against population centers. Nonetheless, the potential for missiles armed with chemical or biological payloads with hydrogen cyanide, mustard gas, nerve agents or anthrax spores or even bigger conventional payloads with faster delivery and greater accuracy aimed at military or population targets emphasizes an unsolved problem for the future.

The Gulf War will produce its own lessons about nuclear, biological, and chemical threats, about war tactics that threaten the environment in the form of oil spills into the sea and oil fires into the atmosphere, about casualties resulting from "friendly fire," and about the challenge of "low-tech" mobile launchers, among others. These challenges, while influencing current allied actions, will also direct DOD's future research agenda.

Under DOD's current plans, strategic forces are to be cut back in accordance with expected arms reductions agreements while maintaining a credible threat to existing stockpiles of nuclear weapons. As Chairman of the Joint Chiefs of Staff Colin Powell recently testified before Congress, the Soviet Union presents both an emerging reality of changed intentions and one essential enduring reality: it remains "the one country in the world with the means to destroy the United States in a single devastating attack."

Nonetheless, retirements of land- and submarine-based missiles, and strategic nuclear bombers are programmed. Acquisition and modification schedules will be scaled back for the Peacekeeper ICBM, Trident submarine, and B-2 bomber programs, among others. Under a refocused defensive concept — global protection against limited strikes -- the SDI program will be reoriented to provide interceptions of limited ballistic missile strikes, whatever the source, as well as tactical theater strikes.

Conventional forces will also be cut back by reducing Army divisions by a total of six, the Navy will field 81 fewer battle force ships, while the Air Force will maintain nine fewer tactical fighter wings. By the end of FY 1995, manpower needs are scheduled to decline by 24 percent from their FY 1987 peak. While the major modernization efforts begun in the 1980s are nearly complete, selective investments will be made in helicopter and armored vehicle programs by the Army; the Aegis destroyer, tactical fighter and missile, and sealift programs by the Navy; and airlift programs, tactical fighter and missile programs by the Air Force.

Investments in RDT&E programs over the next several years will reflect the emphasis on maintaining the advanced technological base in the new political, economic, and military environment. While a "warm" industrial capacity is required, equally important are active research agendas into newly emerging scientific areas and critical technologies.

Research Priorities in the Armed Services

Just as the rapid budgetary growth of the 1980s defense budget did not dramatically increase spending levels for basic research and exploratory development, the retrenchments of the early 1990s are not expected to produce large cuts in these programs. Spending for the technology base program has maintained a fairly flat profile in real dollars over the past decade. Real budget authority for basic research peaked in FY 1986 and has declined slightly in subsequent years. Generally, spending has hovered near $1 billion in current dollars. Real budget authority for exploratory development peaked in FY 1983 and has shown little change since, hovering between $2.5 and $3 billion dollars in current dollars.

Each service has its own central research office which funds extramural research as well as its own in-house and contractor-operated laboratories. The Army Research Office, the Office of Naval Research, and the Air Force Office of Scientific Research are responsible for developing, supporting and managing their respective service's basic research programs in the physical and social sciences. Trends in overall RDT&E funding differ substantially among the services (Table II-5), reflecting the fates of various programs and missions within those services. Air Force and Army RDT&E will increase substantially, while that in the Navy will decline in FY 1992.

Trends in basic research (category 6.1) do not mirror trends in the services' overall RDT&E budgets. The Army, which has the smallest research program, is slated for the largest increase -- 8.2 percent to $197.1 million. Research funding in the Navy will grow 7.2 percent to $421.6 million, while the Air Force is set to receive the smallest increase -- 4.8 percent, to $213.2 million in FY 1992.

Goals of the Army's research program are to support scientific research relevant to three broad areas of application: enhancing the soldier as a system, the armored vehicle, and the helicopter. In comparison to the other services, each of these "platforms" (as they are called) is small. The size constraint underscores the strategic emphasis of many scientific investigations. Power supply and storage are current and future concerns. Climate-controlled environments for the individual soldier on a nuclear, chemical, or biological battlefield require small, light and mobile power units. Logistically simpler, electric-powered armored vehicles with electric-powered weapons delivery systems force similar research directions into alternative power sources. Materials research extends from skins to structures, including composite materials and composite structures. Information processing research extends to communications, command, control, and intelligence areas.

The Navy is pursuing a research program in the basic sciences that supports four broad program areas: sustaining programs, ocean sciences and oceanography, materials, and information sciences. It also has an emerging research agenda into the sailor of the future. With a declining personnel base, with demands for more active sea time and with less time available for in-school activities, newer approaches are needed to approach a maximum utilization of human resources. Newer approaches are needed to develop a more efficient testing of what the sailor knows and does not know for the purposes of quicker training. Sustaining programs support a core of people working in broad areas of basic science that have future naval applications.

More than half of the Office of Naval Research's resources support the other three areas of emphasis. Ocean acoustics, surface reflections and microbubbles, low-frequency acoustics, ocean optics, and the physical properties of small scale regions of ocean are one focus. Materials research into high temperature superconductivity, composite materials, and smart skins to reduce costs and drag, to achieve better fuel efficiency and to enhance performance of existing platforms is another focus. The third focus is on signal processing, laser communication, and the simplification of battle data by reliably transforming it into usable information.

The Air Force is pursuing a research agenda into its own subset of critical areas of science and technology. Notable are four broad categories: hypersonics, space propulsion and power; the space environment and the residual atmosphere in the near-earth environment; human information processing and man-machine interactions; and environmental hazards. Hypersonics involves the creation, testing and development of hypersonic aircraft, investigations of computational fluid dynamics, and mathematical modeling to complement wind tunnel testing. In such modeling, one can iterate through design characteristics and properties and explore fluid dynamics related to surfaces, propulsion, and exhaust gases. Environmental hazards research explores general toxicology and provides the scientific base necessary for evaluating the effects of the military's use of jet fuels, solvents, lubricants, herbicides, propellants, and exotic aerospace materials.

Research Priorities in the Defense Agencies

The Defense Advanced Research Projects Agency (DARPA) is pursuing a research agenda through several offices that investigate defense manufacturing, nuclear monitoring, systems on tactical platforms, the platforms themselves, information sciences, and the physical sciences. The budget request for DARPA in FY 1992 is just under $1.2 billion, down from the previous year's appropriation of about $1.5 billion. The request for DARPA's technology base programs totals $594.9 million, compared with the prior year's appropriation of $765.5 million. Two congressional add-ons account for much of the difference.

In last year's appropriation, Congress added funds for high-definition display research (a host of advanced research initiatives sometimes mistakenly grouped under the heading of high definition television) that is now part of the integrated command and control technology program element. A total one time addition of $75 million was added to last year's request of $37.5 million. For FY 1992, the Administration has proposed a return to previously established levels with a request of $35.5 million. Congress also added funds for X-ray lithography in the materials and electronics technology program element. A total of $43.1 million was requested last year; $155.4 million was appropriated. The FY 1992 budget request includes $62 million for this area of research.

In basic research, DARPA plans to emphasize three broad areas: electronics, materials, and electromagnetic devices. The electronics area includes opto-electronics, gallium arsenide, heterojunction bipolar devices, quantum well devices, and neural networks. In advanced materials research, support focuses on high temperature superconductors, metal matrix composites, ceramic matrix composites, and electrochemical power source materials. In electromagnetic devices area, the focus is on lasers, compact lasers, and radio frequency sources.

As part of a multi-agency effort, DARPA plays a special role in the High Performance Computing Initiative. The agency's dual concentration is on computer architectures and software to tackle such challenges to current power capabilities as aerospace vehicle design and climate modeling. Research emphases will be placed on scalable parallel computing systems and advanced software environments and algorithms. Work on advanced manufacturing processes will continue, with special emphasis on semiconductors through SEMATECH.

The Strategic Defense Initiative Organization, as noted above, is to be sharply refocused on global protection against limited strikes. This new system architecture will drive its research agenda in several directions. One critical area (for which $271 million is requested in FY 1992) is weapons systems environment (solar background, earth background, space particle fluxes, clutter levels against earth backgrounds). In each case the question asked is: What do objects in space look like against different backgrounds with different sensors? The budget also proposes R&D funding for passive sensors ($187 million), for hypervelocity projectiles ($134 million), for semiconductor materials ($62 million), for sensitive radars ($47 million), for simulation and modeling ($45 million), and for signal processing ($35 million).

The University Research Initiative (URI) was created several years ago to strengthen ties with the university scientific community, to stimulate defense-related research in academia, and to develop the engineering and scientist pool necessary for maintaining research agendas that are important to the national defense. Other DOD special programs support defense related fellowships, scholarships, cooperative research ventures, opportunities for historically black colleges and universities (HBCUs) and other minority institutions, and opportunities for small businesses. A new URI competition for the five year multidisciplinary portion of the program has just opened and will be funded under the FY 1992 appropriation.

Last year, the URI program (included within the request for the Office of the Secretary of Defense) attracted considerable congressional attention. The FY 1991 request called for $98.6 million, but Congress appropriated $230.7 million. Earmarked funds were added for specific universities and centers, by-passing standard peer review procedures and enlarging the academic pork barrel. In addition to the pork barrel items, Congress also added $20 million for fellowships and $50 million for traineeships, as well as a Japanese Management Program and Management and Engineering Training Program. The FY 1992 request is for $87.4 million, suggesting a return to the level of effort maintained in earlier Administration budgets.

Chapter 6

National Science Foundation, FY 1992

Association of American Universities

John C. Crowley, Kathie Bailey

After Four Losing Seasons, NSF Team Seeks A "Closer"

Since 1987 both the Reagan and Bush administrations have announced annual presidential initiatives to rapidly double the budget of the National Science Foundation. For each of the last four budget seasons the NSF game plan was sound, all players wanted to turn things around, and the Foundation's fans supported it enthusiastically.

Last year, despite strong efforts in Congress, a bizarre final play, orchestrated by the President's own Office of Management and Budget, cost the Foundation's research programs another $40 million. As a result, many research programs again fell well short of the President's goals for them. Only several programs in Computer & Information Sciences and Engineering and the acclaimed rebuilding of the Foundation's Education and Human Resources programs, accelerated by Congress, have met and exceeded presidential goals.

Final congressional action on the fourth year of the doubling plan, FY 1991, left nearly half–41 of 84–of the programs in four directorates at their effective FY 1988 levels. These programs account for more than 70 percent of total research funds. Across five divisions of the Mathematical and Physical Sciences, which accounts for one-third of total NSF research funding, two-thirds of the programs – or 18 out of 27– were cut to below their FY 1988 levels. Only seven MPS programs have grown by more than 4 percent in real terms since FY 1988. Across the five divisions of Engineering, two-thirds -13 of 20-programs remain below real FY 1988 levels; of these many are funded 6 to 10 percent below their effective FY 1988 levels. In the Biological, Behavioral, and Social Sciences, 8 of 23 disciplinary programs remain below their FY 1988 levels; 5 others have experienced real growth of less than 1 percent. Two programs in Computer & Information Science and Engineering remain 10 and 16 percent under their FY 1988 levels, while 2 others have grown by less than 5 percent. Many programs continue to lose strength. The reasons appear largely unrelated to the development of the Science and Technology Centers now institutionalized in each research directorate.[1]

The FY 1992 budget sustains the doubling strategy by proposing a 17.5 percent increase for NSF, widely seen as generous in a time of constrained domestic spending. But if Congress fully funds NSF at the level of the budget request, what will be accomplished in real terms? For many programs, a good deal; for others, much less. In BB&SS all but 3 programs will achieve at least a small margin of real growth; eleven programs will recover to increase by more than 10 percent over their levels of 5 years ago. In Engineering,6 programs will remain below their 1988 levels; three will grow less than 5 percent; the rest will attain greater growth. Seven MPS programs, including 3 in mathematics, will remain below their FY 1988 levels, 7 others will grow by 5 percent or less above their pre-FY 1988 levels. At full funding real increases above FY 1988 levels will be small: mathematics up 5.7 percent; astronomy up 6.0 percent, physics up 2.3 percent, chemistry up 1.2 percent and materials research up 4.8 percent. If significant cuts are made in the FY 1992 request, many– maybe most–MPS programs will again fall below their FY 1988 levels in real terms.

Research programs are further threatened by the OMB-driven decision to terminate the new NSF Academic Research Facilities program. Congress is likely to restore the program, and many will rightly urge it to do so. If, however, Congress reallocates the funds from research programs, OMB's decision will become a budgeted "poison pill" for them.

Full funding of the budget request will not fully address consequences of the continuing failure of the doubling plan. Even if the FY 1992 budget is fully funded, the size of the median research award will probably continue to shrink in current dollars. Intensifying competition for limited funds is leading NSF to make a larger number of smaller grants and to hold awards to an average duration of 2 years, not the 3 years proposed a few years ago to bring needed stability to the enterprise. The erosion of the value of research awards in both current and constant dollars is requiring researchers to seek several grants from multiple sources to sustain the work of a single laboratory. The "hassle factor," an essential component of a vibrant competitive enterprise, is now pressing many investigators beyond reasonable and productive limits.

As NSF enters this fifth season of its doubling campaign, the odds of success are lengthened by new, tighter budgeting rules applied last year to all domestic discretionary spending. Some competing domestic interests which are much shorter of funds already propose to overturn the budget agreement itself.

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[1] In the final operating plan for FY 1991 and in the FY 1992 request, Science and Technology Centers account for slightly more than 1 percent of Geosciences funds, about 3 percent each of total BB&SS and MPS funds, and less than 5 percent of CISE funds. Engineering Centers accounted for about 23 percent of all Engineering funds in both years.

A loyal supporter can ask, "Why has the Foundation lost so many excellent budgets? What happened to January's visions and sense of urgency each October? What needs to change to have a solid winning season this year?"

The four disappointing budget seasons are not the products of fuzzy policy goals, inadequate supporting data or analyses, poor presentations to Congress, or, for that matter, shortages of inspiration or perspiration. Although some will always second guess the details, the proposals of both the Reagan and Bush administrations were widely applauded as solidly conceived. The Foundation made its case to Congress effectively.

The Foundation has had more help than ever before. Recently, voices of industry, long absent from the NSF appropriations effort, have joined with those of the Foundation's traditional academic constituents in urging Congress to support the President's goals for NSF. In addition, a steady flow of new government and privately sponsored reports continues to illuminate and reaffirm the strong links between investment in science, engineering and education and our technological and economic development, our national welfare and our future security. Newly formed coalitions also have joined with the traditional constituents of NSF, the science and engineering societies and higher education associations and their members, to support the President's NSF initiatives. All of these national organizations keep their members back home informed; many of them also ask for the support of their Congressmen and Senators.

Congress itself is not the problem. Congress quickly and overwhelmingly endorsed the doubling goals several years ago. Members on both sides of House and Senate appropriations committees steadfastly profess their support for NSF. No congressional opponents to the President's goals for NSF have appeared.

Nevertheless, if all participants play their same game again this year, the President's goals for NSF research programs may lose for the fifth straight time. And this year, they could lose big.

The root of the problem does not lie in the substance or presentation of the Administration's proposals. It lies instead in the context of the debate over NSF funding and in the failure of key players to execute at their positions at crucial moments, especially during the game's final minutes, when "franchise" athletes, like expert salesmen, earn their status. NSF is still seeking its own franchise "closer."

As this year's appropriations game enters its final minutes, after NSF and others have played their positions fully, President Bush will signal to Congress his highest priorities for the VA, HUD, Independent Agencies Appropriations bill. Those White House signals could again decide the fate of NSF's research and education budgets for FY 1992. To secure his goals for NSF, the President and his White House representatives will need to actively support it and protect it throughout the appropriations process and urge others to join with the President in the effort.

If the White House itself fails to press the NSF goals fully and effectively with Congress, then appropriations subcommittees may respond to competing pressures by reallocating a generous portion of NSF research funds to other purposes, including any others specifically protected by last-minute White House intervention. At the end of the process,Congress can have no doubt that the President stands by the priorities for NSF in his January budget request and in his Valentine's Day address to the AAAS.

Therefore, as NSF advocates rightly thank the President for his leadership again this year, they may want to add, respectfully, "Great opening pitch, Mr. President. But please, this year have the White House team play the entire game, and together let's win one for a change."

A Summary of the FY 1992 Budget Request

Themes

- Sustain the President's commitment to double the NSF budget by 1994
- Strengthen the research base, with budgeted increases focused on the needs of individual investigators, and their research infrastructure;
  - — accounts for about 75 percent of the request, an increase of 17 percent.
  - — emphasizes growth in "forefront, high-priority areas,such as materials research, biodiversity, plant sciences, global change research, computational sciences and high performance computing, as well as support for basic disciplinary research."
- Develop human resources, broaden participation, and improve science and engineering education and training at the precollege, undergraduate, graduate and postgraduate levels.
  - — supports about 30,000 graduate and undergraduate students at 1,200 colleges and universities;
  - — precollege programs: more than $250 million with emphasis on improving science and mathematics instruction in elementary and secondary schools; includes doubling to $31 million funding for the Statewide Systemic Initiatives program, designed to develop federal-state cooperation;
  - — undergraduate programs: $133 million added emphasis on Course and Curriculum Development, in science, engineering and mathematics, and Research Experiences for Undergraduates;
  - — women, minorities and disabled; $100 million, up 25 percent;
  - — Experimental Program to Stimulate Competitive Research (EPSCOR): $15 million, up 36 percent, to initiate an Advanced Development Program.

Highlights of the FY 1992 Budget Request

	Request	Increase (millions)	percent increase
Total	$ 2.72 billion	$ 406.0	$ 17.5
Research & Related	1.96 billion	269.3	15.9
Education and Human Resources	390.0 million	67.65	21.0
U.S. Antarctic Program	193.0 million	18.0	10.3
Salaries and Expenses	122.0 million	21.0	20.8
Inspector General	3.5 million	0.5	16.7

Presidential Initiative for Academic Research Instrumentation	50.0 million	a new competitive program for high-cost, state-of-the-art instruments; "at least" 50 percent cost sharing.
Research Facilities Modernization		After an initial round of awards totaling $39 million, OMB proposes to terminate this Congressionally initiated program, the only operating, competitive matching grant program for the modernization of academic research facilities among research agencies.
High Performance Computing & Communications	213 million	NSF plays a co-leadership role in this government-wide initiative coordinated by the Federal Coordinating Council on Science, Engineering and Technology.
Global Change	118.5 million	NSF also leads this FCCSET initiative.

• Materials Synthesis	$ 84.0 million	New; will strengthen science and engineering essential to the development and use of critical technologies, and materials processing methods.
• Laser Interferometer Gravitation Wave Observatory		Last year's $46.5 million request for LIGO was denied; $23.5 million is requested.
• 8-meter optical/infrared telescopes		Two, one per hemisphere, funded over 8 years, half with the U.K., perhaps Canada; a total cost of $176 million; $16 million is requested.
• Centers		Previously awarded Science and Technology Centers and Engineering Research Centers are sustained at proportionately reduced levels in FY 1991, and their funding increased in FY 1992. Awards of a second class of new S&T Centers, approved in August 1990, will be announced in early 1991. No additional S&T or ER Centers are proposed for FY 1992.
• Research Award Size		In response to proposal pressure, research award size is cut, the number of awards increased, and duration of awards unchanged at about two years. Award size is failing to keep pace with research costs and is actually falling in current dollars. In FY 1992, NSF proposes to increase the number of awards by more than 13 percent above FY 1990 levels.

	median annual award size	
	FY 1990	FY 1988
Biological, Behavior and Social Sciences	$55,000	$55,000
Computer and Information Sciences and Engineering	$60,000	$55,273
Engineering	$55,265	$53,934
Geosciences	$62,500	$60,260
Mathematical and Physical Sciences	$56,854	$55,000
STIA	$14,198	$13,908
Education and Human Resources	$20,000	$26,797

- People Supported

  Assuming full funding of the budget request, the number of supported senior scientists will increase by about 25 percent above FY 1990 levels to 24,720; postdoctorals will increase nearly 15 percent to 4,300; and graduate students will increase by 25 percent to 20,738.

- Award Volume

  Research proposals received will increase by 19 percent above FY 1990 levels to 38,626. At full funding, 18,381 awards, up 14 percent, are predicted. Universities will receive about $1.6 billion and industry $41 million.

Biological, Behavioral, and Social Sciences $355.74 million + 12.8 percent

- BB&SS provides nearly one-third of total federal support in the behavioral and social sciences, 75 percent of all federal support in environmental biology, and is the sole source of support for academic research in anthropology.
- support for individual P.I.'s is increased $34 million, or 12.3 percent, to $311 million.
- "highly competitive beginning investigators" will receive five years of support; 90 percent of BB&SS funds support individual investigators.

- research activities emphasized include a model plant genome, global environmental change, computational life sciences, biomolecular materials and intelligent systems.
- a new research and training center for survey methods is proposed.

Computer and Information Science and Engineering — $229.50 million — + 23.3 percent

- NSF provides 60 percent of federal academic research funding in these fields.
- increase investigator-initiated research,strengthen university infrastructure, enhance advanced scientific computing and networking facilities through the FCCSET High Performance Computing and Communication (HPCC) initiative.
- provide $208 million of the total $213 million NSF contribution to the HPCC, BB&SS and MPS also participate, as follows:

— High Performance Computing Systems	$24.0 million
— Advanced Software Technology and Algorithms	100.0 million
— National Research and Education Network	33.0 million
— Basic Research and Human Resources	51.0 million

- continue upgrades of Supercomputer Centers; expand NSFNET.

Engineering — $247.70 million — + 14.8 percent

- NSF accounts for about 28 percent of total federal support for academic engineering.
- increase support for individual investigators and small groups by $22 million, or 19.1 percent, to $137 million.
- with BBS and MPS, increase emphasis on advanced materials.
- earthquake engineering, up 16.4 percent to $17.75 million.
- increase State participation; increase the number of State/Industry/University Cooperative Research Centers from 5 to 15; strengthen existing Industry/University CRCs.
- start a new engineering education coalition, for a total of four supported at $10.6 million, to strengthen the undergraduate engineering education, expand participation of women, minorities and the disabled.
- support about 360 Presidential Young Investigators, $20.6 million, plus about $10 million in industrial cost-sharing.
- strengthen Research Experiences for Undergraduates to $4.15 million.

Geosciences $419.54 million + 14.1 percent

- NSF through GEO provides about 70 percent of all federal support for academic research in the geosciences.
- increase support for individual investigators to $279.57 million, up 14 percent, to about two-thirds of the total Geosciences budget request.
- support laboratory studies, field experiments, modeling activities, the National Center for Atmospheric Research (NCAR) and the research fleet at $128.9 million.
- Geosciences accounts for $84.94 million, up $26.2 million, of the $118.50 million NSF participation in the FCCSET Global Change program.

Mathematical and Physical Sciences $650.08 million + 16.4 percent

- NSF accounts for about 75 percent of total federal support for academic mathematical sciences, two-thirds of support for ground-based astronomy, one-third of support for academic research in elementary particle physics, one-half of support in nuclear physics, about 30 percent of federal support for academic research in chemistry, and 50 percent of federal support for academic research in materials.
- emphasize individual investigators conducting disciplinary research.
- allocate $51.5 million for several major construction projects:
    - two 8-meter optical/infrared telescopes,
    - continue the National High Magnetic Field Laboratory,
    - start the Laser Interferometer Gravitational Wave Observatory,
    - with NASA, upgrade the radio telescope at Arecibo.
- augment the 6 S&T centers by 12.3 percent to $21.03 million.
- increase undergraduate curriculum development and Research Experiences for Undergraduates $3.2 million to $18.92 million; expand women, minorities programs.

Scientific, Technological, and International Affairs $61.04 million + 19.6 percent

Note: On October 1, 1990, $16.32 million of human resources activities were transferred to Education and Human Resources.

- provide through the Small Business Innovation Research (SBIR) program $24.54 million to companies to foster commercialization of high technology products and processes; 275 Phase I and Phase II SBIR awards are planned.

- establish the College and University Innovation Research program, postponed from FY 1991, as a test of the SBIR concept in an academic setting; 16 awards are planned.
- improve scientific relations with Latin America, encourage U.S. faculty to obtain international experience, and establish cooperative research activities with the Soviet Union and Eastern Europe.
- redesign the Scientific and Technical Personnel Data System.
- $15 million for the EPSCOR program expanded in FY 1991 to 18 states and Puerto Rico, to initiate an Advanced Development Competition.

Education and Human Resources $390.0 million + 21.0 percent

- The FY 1992 request follows a 46.1 increase, mandated by Congress, in FY 1991.
- precollege science and mathematics education: increase by $40.4 million, or 19 percent, to $253 million on top of a 29-percent increase last year; this accounts for 65 percent of the total EHR request.
  - — double to $31 million the Statewide Systemic Initiatives Program,
  - — expand the Young Scholars program.
- undergraduate research and education: increase by $16 million, or 30.4 percent, to $47 million; undergraduate activities account for 17.6 percent of the EHR request.
  - — initiate the Alliances for Minority Participation Program,
  - — expand the introductory-level Course and Curriculum Development Program,
  - — hold instrumentation and laboratory development to the current level, $23 million.
- graduate fellowships: hold the current level of 1,060 offers per year, including 150 for the Minority Graduate Fellowship Program; increase the stipend to $14,000; the budget is silent on the accompanying cost-of-education payment.
- establish a new component of the graduate fellows program, two-year Career Development Fellowships, for seniors in predominantly minority institutions.

U.S. Antarctic Program $193.0 million + 10.3 percent

- expand the multi-year Safety, Environment, and Health (SEH) initiative.
- increase research by $3 million to $22 million.
- continue outfitting a new research vessel.

Chapter 7

Health Research (HHS) in the FY 1992 Budget

National Association of State Universities and Land-Grant Colleges

Jerold Roschwalb

Introduction

"If there were ever a year when the numbers did not even begin to tell the full story, this was it for NIH." That statement opened the section on NIH in AAAS' December 1990 Congressional Action on R&D in the 1991 Budget text. That theme continues in this chapter on the Administration's FY 1992 budget proposal for health research.

In past years, we have devoted attention to what seemed like an annual effort by OMB to reorient the funding processes and mechanisms of NIH. Some would argue today that had we not stressed the appropriations implications of the OMB proposals alone, but had noted their consequences for what is being called cost containment or improved management, we might have obviated the current tensions.

In short, the appropriations for FY 1991 were properly called "routine," allowing decent increases for NIH and ADAMHA. The budget request for 1992 is similarly "routine," but the administrative environment in which funding now must operate demands change and consequent anxiety.

(Circumstances for ADAMHA parallel NIH in appropriations. While there have been no directives from the Congress to ADAMHA on cost containment, it is understood that administrators are looking into the issues to anticipate similar management directives.)

National Institutes of Health - FY 1991

(For the accuracy of numbers in this chapter and the more useful commentaries, credit is due to NIH and ADAMHA staff. My thanks for their assistance and patience.) The total NIH budget for FY 1991 was $8.277 billion. This sum equalled a 9.2 percent increase. (Almost 10 percent of the total will be concentrated on AIDS. Another area of special attention is the human genome project, increasing to $87.4 million from about $60 million.)

Research project grants (RPG's) are allocated $4.5 billion and grows in number by 905.

Six hundred and seventy research centers will be funded with $713.5 million, 48 more than in FY 1990.

Traineeships have $306.4 million for 12,178 trainees, an increase of 411. The Office of the Director has $19.3 million for a discretionary fund along with other funds administered by that office, and the authority to transfer up to one percent of each institute's funds to deal with emergencies or high priorities.

The subcommittees in both House and Senate indicated specific concerns: after 20 years of large funding, the Cancer Institute has not produced sufficient results in the prevention or cure of the most dreaded disease. The committee expresses "impatience" and indubitably reflects the attitude of the American public, grown accustomed to putting cash down and, at once, getting whatever it pleases in return. The committee, as will be noted below, also had many general concerns, despite which it produced, under great pressure from other social programs, a budget that permitted real growth for medical research.

National Institutes of Health - FY 1992

With the FY 1991 appropriations as background, and the accompanying instructions from the committee as guidelines, the Administration sent the following request to the Congress: the total requested for NIH is $8.775 billion. This is $498 million over last year and equals a 6 percent increase. (AIDS research, up to $851.2 million, has a comparable increase. The human genome, however, still in a program developing stage, increases by 26.4 percent to a $110.5 million total.)

Agency documents stress the attention to research intensive mechanisms, which grow by 7.6 percent, and Research Project Grants (RPG's), which grow by 8.8 percent. With the Biomedical Research Development Price Index (BRDPI) at 5.8 percent, this allows 3 percent of real growth for RPG's.

The approximately 6,000 competing grants sought by the congressional committees is met with 5,785 awards, somewhat short of the mark, but the highest number reasonable given budgetary constraints.

The agency notes that if the funds requested are granted, they would support the highest number of RPG's ever along with the highest numbers of Principal Investigators (PI's). Also of note, the funding rate for competing grants rises from 24.1 percent in FY 1990 to 26.4 percent in FY 1992.

FY 1992 would have research training at $314.6 million and cover 12,318 trainees (+$8.3 million and +140 trainees). Documents note that NIH will increase the ratio of predoctoral to postdoctoral awards as insurance for the supply of researchers at the start of the next century.

Special attention has been given to programs devoted to dealing with the state of minorities' health and their representation in the most competitive research institutions. The four programs devoted to these goals are increased by 26.1 percent ($89.3 million/$112.6 million).

The salary cap of $125,000 per year is extended into the new fiscal year.

Some other notable details: $15 million will initiate a new facilities program to assist historically black colleges and universities. The Biomedical Research Support Grant (BRSG) program is eliminated. This budgetary ritual of excision began at least 15 years ago with Congress restoring and maintaining the program until recent years, when the program was cut from its high of about $60 million to a level of $17 million last year, of which $5 million was directed to a program for enhancing minority participation in medical research. NIH has placed BRSG at the bottom of its list of priorities notwithstanding the insistence by research administrators that the flexibility provided by the relatively small amounts of dollars was invaluable in promoting careers of young scientists among other virtues. Given current fiscal pressures, the program appears to be in serious danger lacking any champion in the Congress.

Intramural Research rises to $987.9 million, a 6.8 percent increase aimed at covering within grade increases of personnel as well as the impact of inflation on the cost of laboratory and hospital supplies.

The National Library of Medicine shows a 10 percent increase. The budget also provides $2 million for the Office of Biomedical/Life Sciences Education tied to the major interagency education initiative and is focused on precollege education and adult science literacy.

$2.5 million is asked for the Office of Women's Health Research. NIH took flak before the House subcommittee for what seemed like indifference to the concerns for the state of women's health and the participation of women in clinical trials. There is much interest on the Hill, and this program will move forward. Finally, the Director again receives $20 million for the discretionary fund. In FY 1991, the money was used for pilot efforts in science education, minority health, and women's health.

(Please see charts for breakdowns by individual institute and mechanisms.)

Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA)

The ADAMHA budget differs markedly from NIH because of its major focus on treatment, including state block grants. The research budget of ADAMHA is approximately one-third of the total agency appropriations. The FY 1992 budget increases $82.8 million (+8.4 percent over FY 1991). The recent larger increases of this agency above NIH may be due in part to making up for prior neglect of the agency, particularly in its research responsibilities. In FY 1992, the agency budget proposal passed the $1 billion mark for the first time. (The same dollar increase at NIH would be only slightly more than one percent.)

Mental Health (NIMH)

The total research budget will be $561.8 million, up from $521.8 million. RPG's will grow by 28 to 1,248 and $280 million compared to $258 million in 1991. The number of centers will remain the same, 50, while the funds increase $3.6 million to $67.2 million. In the category of "other research," including career programs, cooperative agreements, instrumentation grants, and small grants, all the numbers of grants remain static and funding rises by about $.4 million.

In training, the numbers remain the same and funding rises by $.64 million. Contracts remain the same, 60, and funding (reflecting inflation) goes up by almost $30 million to $427.9 million. Finally, Intramural Research grows by $7 million to $92.8 million with the full-time equivalent (FTE) numbers remaining the same.

Drug Abuse (NIDA)

In drug abuse, the funds for RPG's rise from $173.9 million to $186.4 million, with new grants dropping from 251 to 194. Other research rises to $15.8 million from $13.9 million. Training remains static, though the dollars rise by $.24 million to $7 million. Contracts grow from 77 to 86 and dollars increase from $242.2 to $267.6 million. Intramural grows by $1.5 million with 113 FTE and total research grows from $297.4 million to $327.7 million.

Alcoholism (NIAAA)

The total research budget grows from $154.8 million to $166.8 million. Increases are inflation or less, by and large, with RPG's growing from $87.6 million to $93.8 million; centers from $17.3 million to $18.2 million; other research dropping in numbers from 73 to 70, and holding the line in dollars; training rises from $3.5 million to $3.7 million. R&D contracts grow from 14 to 19 and from $124 million to $133.9 million. Intramural shows an increase in dollars only from $18.9 million to $20.2 million.

The main focal point this year appears to be in the area of medications development, in which there is a 48 percent increase over FY 1991 and a 100 percent increase over FY 1990. Each of the three agencies is involved, with NIMH growing 80 percent this year, NIDA 39 percent, and

NIAAA 286 percent. The reason for the latter surge is that the agency had only $.7 million in 1990, $.88 million in 1991; it grows to $3.4 million in 1992.

NIDA is slated for $55.5 million and NIMH $9.4 million. Of this $68 million, more than two-thirds, $48 million, will be devoted to research, the remainder to demonstrations. The quest is for drugs to reduce craving for abused drugs and block the behavioral and physiological effects of such drugs. Also sought are replacement therapies to treat drug addiction, to ease the process of withdrawal, and reverse toxic effects of abused drugs.

The agency's $170.2 million is mostly devoted to antidrug spending. The budget to some degree reflects differences in conceptual approaches to the problems of mental health and substance abuse. In recent years, administrations have focused on the substance more than the affected persons. Some claim that logic would have far more dollars spent on the preventive side. New/competing awards declined from 754 to 664 in a total of 2,473 RPG's, approximately same number as FY 1991. Grants, on average, increase 5.7 percent--the biomedical research deflator. Of the total increase in research, $22 million is dedicated to expanding medications development work.

ADAMHA also will engage in the science education initiative aimed at public awareness of the benefits resulting from the conduct of science. It is a K-12 program, and ADAMHA will spend $2.3 million on this.

ADAMHA's AIDS budget also grows, to $8.3 million (+3.5 percent), basically an inflationary increase for ongoing research.

Financial Management/Cost Containment

The health research community got a double bonus in the FY 1991 NIH budget. First, it could analyze and bemoan the directives contained in the report language for the appropriations bill for FY 1991. Then, having awaited the mandatory response from NIH, the community could meet and assault the agency's proposals as salt in the wounds from the Congress. The following is a summary of the points made by the committees in the report.

First, they recognized that low numbers of grants were mischievous, but thought that the claims of crisis in funding were "overstated." Next, "Downward negotiations" and a "general lack of stability" also vitiated "the vitality and morale of the research community, which had to be restored." Shortfalls in funding were a problem, but there were others. After all, in the past eight years appropriations had risen from $4 billion to $7.6 billion (FY 1983-1990) and new grants had risen steadily from 5,389 to 6,453 before beginning to descend and plummet. Total grants, of course, never did fall off in any serious number and were now well beyond a total of 20,000 per year.

The first problem: the average length of grants in the past decade has increased from 3.3 to 4.3 years. (The committee stresses that the NIH decision to increase the length of grants was made without consultation with the Congress.) Second, the average cost per grant has increased unreasonably, 94 percent between 1981 and 1990. Inflation cost about half that amount.

This compelled arbitrary cuts -- called "downward negotiations" by the agency -- that caused difficulties for the scientists and their home institutions. The committee calls on NIH "to implement more aggressive cost management and cost control measures" and proposes the following items:

- The target is a stable research grant pool -- 6,000 new and 24,000 total grants per year. (The report says that enough funds were provided for 1991 to support "approximately 6,000 new grants," to insure that the average length of a grant will not exceed approximately four years, and see to it that the average cost of a grant will not grow faster than the BRDPI. "This can be accomplished by specific cost management strategies or by factoring cost into the grant selection process or both." (The latter raised eyebrows and concern.)

- The total cost of a grant, including indirect costs, should be considered at all stages of the grant review process. (A major concern.)

- Eliminate downward negotiations. Through the process of awarding grants, study sections and advisory councils should cut costs where possible. Action should be compatible with science. However, once a number is decided on for what science needs, there should be no arbitrary reductions. This applies to RPG's and centers in FY 1991.

- NIH may modify the peer review system to remove the current "approval language." If only half of the projects are considered deserving of support, the review program should state that. The number of trainees should be the number recommended by the National Academy of Sciences.

- Center grants should not exceed 640. New center grants should be funded as others phase out. The total budget for centers will be increased to reflect inflation.

- Funding for all of the mechanisms will be increased to reflect inflation.

- The NIH Directorate should have a contingency reserve to deal with emergencies and special opportunities. In FY 1991 this fund is allocated to the director. In future years it should be divided between the director and the individual institutes.

The report went on to say that if NIH wanted to amend the plan, modifications must be compatible with "the goal of stability and predictability during a period of planned growth." Finally, it noted that unique challenges, such as the AIDS epidemic, would arise and that the committee would respond to special requests as long as they could be justified before they would be approved. The committee also called for program balance, recognizing the task of the new director to convince "his peers" of the importance of balance.

The OMB Passback

In the hallowed tradition of budget development, there is the moment when the agency receives word from OMB on how it has responded to the initial request, with one final appeal left. Not surprisingly, the document sent back to

HHS on NIH concurs rather expansively with the congressional committees' directives.

Much to the chagrin of the research community, especially those in private research universities, OMB also expects that each initial reviewing group "will manage costs by reviewing both components of total costs, indirect and direct, at every level, and review as necessary to contain costs." Neither should rise faster the BRDPI.

NIH was mildly chastised for having failed to insure that it would be able to sustain its grant programs, "and should not sow the seeds of future discord within the research community." Voices had warned that those three years of 6,000+ competing grants would wind up with 4,600 a year unless Congress vastly increased funds. There is apprehension that the higher indirect rates in private institutions could make them less competitive. OMB also asks for a study "to assess the quality of research." It is concerned about variable quality among the institutes.

OMB is most concerned about the "dismal efficacy rate" of the NIH training programs and wants to improve the "astonishingly low rate at which NIH-supported trainees and fellows apply for NIH grants." Also, there is concern that increased stipends "will again be siphoned off by universities" unless some maintenance-of-effort provisions are built into the training grants.

With such concurrency of views between the congressional committees and OMB, NIH had little recourse but to get to work quickly.

A document called "A Plan for Managing the Costs for Biomedical Research" has been circulated by NIH officials seeking the commentary of scientists, administrators, and others. It never was entirely likely, despite the efforts of NIH officials, that the agency could comply with the directives of the Congress and the advice of OMB and concomitantly not raise the concerns of the research community.

NIH presents the following facts as introduction to its financial management plan:

1. NIH grew 124 percent between FY 1980 and 1990. Once corrected for inflation, the increase was 24 percent or an annualized real change of 2.1 percent.

2. The average cost of a grant in that period grew 98 percent. Factor in BRDPI and the increase is 16 percent, a real change in the average cost of RPG's of 1.7 percent.

3. Once inflation is built in, the annualized real change in indirect costs was 2.5 percent; 1 percent indirect costs. Further, the major increase in indirect costs occurred in the first half of the period. Indirect and direct costs grew at about the same rate in the second half.

4. The total number of new applications in the period grew by about 36 percent along with the total number of applications.

5. While applicants were increasing by 36 percent and more, the number of awards grew only 12 percent.

6. Downward negotiations grew from an average of 3.2 percent in FY 1980 to about 15 percent in FY 1990 in competing grants. In noncompeting, the cuts ranged from 2.9 percent to 11.3 percent. (The increases between 1980 and 1987 in the percentage of GNP devoted to nondefense R&D include France: .4; West Germany, .3; USA, .1.)

The NIH Plan

- The length of awards will average four years. Ironically, this may increase costs because it will mean more frequent applications with more frequent reviews and more handling of paper.
- There will be major attention on the initial review groups (IRG's) to make an effort to reduce unnecessary costs. Where they do not accomplish this, councils and boards will pursue the goal. "NIH believes that, in implementing its financial management plan, it is critical that the quality of research not be sacrificed in the interest in awarding low-cost grants." However, it will consider making awards "out of order" of the percentile ranking if the quality is such so as to justify that and the costs demand it.

- Indirect costs should be subject to a review by a panel that NIH will recommend the executive branch establish -- "to determine if such costs can be reasonably contained without jeopardizing the ability of granting institutions to conduct research."

- Approval rates are out. A success rate will be used comparable to that used in all of the federal agencies, a simple ratio between applications and awards.

- Training. The agency will follow the recommendations of the NAS, but if funds are unavailable for both increased stipends and numbers, it will stress stipends first.

- NIH rejects an arbitrary cap on the number of centers as not consistent with the agency's obligation to take advantage of different research environments. In fact, it notes that the increase in numbers may be attributed at times to congressional directives to establish new centers. It will do its best to keep costs down.

- NIH thinks it unwise to distribute the Director's contingent reserve across the agency and recommends that it stay within the Office of the Director so that emergencies and imbalances may be addressed.

It will work out. NIH has no greater supporters than the committees that sent them the directives. The new director will be given an opportunity to organize the agency while implementing the directives in reasonable fashion. OMB's penchant for generating mischief will take a back seat, since those very bright officials understand what NIH is about and will seek to enhance it even if the approach seems a bit strange.

We may dedicate this year's appropriation to the late Gilda Radner who would observe, "It's always something."

Chapter 8

R&D in the Department of Energy

American Association for the Advancement of Science

Margaret O. Meredith

Highlights

- R&D at the Department of Energy (DOE) would grow 8.5 percent to nearly $8.0 billion under President Bush's FY 1992 budget proposal.
- An increase of 34.6 percent ($393.8 million) is planned for General Science, with most of the new money going to the Superconducting Super Collider (SSC).
- The most notable increase in DOE's budget is slated for the SSC, which is proposed to receive a total of $522.7 million, more than twice the amount authorized by Congress this year ($235.8 million). The increase proposed for the SSC claims 45.6 percent of the new money requested for DOE in FY 1992.
- DOE's energy programs would be cutback under the FY 1992 budget. The $3 billion proposed for energy programs falls 1.8 percent below the FY 1991-enacted level.
- Despite an overall decrease in R&D funding for energy programs, the budget contains healthy increases for some energy programs, including Nuclear Energy (up 28.6 percent), Energy Conservation (up 27.2 percent), and Magnetic Fusion (up 22.9 percent).

- Atomic Energy Defense Activities (AEDA), which account for almost two-fifths of DOE's total R&D, would receive $164.2 million in new money in FY 1992 (a 5.5 percent increase), bringing the total to almost $3.2 billion. Over half of the proposed increase would go to the New Production Reactor.

- Environmental Restoration and Waste Management would increase 60.3 percent for a total of $330.3 million in FY 1992.

INTRODUCTION

The 8.5-percent increase the Administration has proposed for DOE in the FY 1992 budget masks the far less generous proposals for many programs, particularly energy programs. Two of the three legs of the Department's budget, General Science and AEDA, are scheduled to increase, but nearly half of the new money is targeted for one program, namely the SSC.

On the other hand, the budget request for energy programs, which are proposed to decline 1.8 percent overall, does contain some significant increases for a few select programs. Most of the growth is allocated to programs having potential to meet near- to mid-term energy needs, which reflect the "results oriented," "market sensitive" approach recommended for the Department in the National Energy Strategy released in March.

The Administration's proposal continues a trend begun last year to bolster support for conservation programs and some renewable energy programs, specifically photovoltaics and biofuels. In addition, the Department's budget includes new money in several programs for long-needed improvements in infrastructure, prompted in part by a new emphasis on safety and environmental protection. The Administration reverts back to traditional patterns with the Fossil Energy budget, which would be cut drastically across the board.

Growth proposed for AEDA programs is distributed in a more egalitarian fashion than in the General Science or energy programs. The FY 1992 budget places emphasis on the New Production Reactor, although other major programs also receive relatively generous increases.

Discounting the SSC, programs with a heavy emphasis on basic research increase modestly in the FY 1992 proposal. General Science programs (excluding the SSC) would receive $106.9 million in new money under the FY 1992 plan. The budget for Basic Energy Sciences is essentially flat, however.

1. ENERGY SUPPLY R&D

About one-quarter of the Department of Energy's budget request for R&D is designated for activities in Energy Supply R&D. The FY 1992 request breaks with tradition and proposes increased funding for R&D for this appropriation --5.8 percent over the FY 1991 enacted level. Most of the growth is directed toward Nuclear R&D and Magnetic Fusion, while many of the remaining programs are targeted for cutbacks.

Solar and Other Renewables

Programs within this account have been restructured into categories that are more closely aligned with end-use markets, such as transportation and utilities. Energy Conservation was restructured in a similar fashion. The restructuring reflects a shift in the orientation in Department management to a more "end result" and "market sensitive" approach.

All of the former source-derived categories under Solar and Other Renewable Energy are subsumed under the new sector-oriented classifications. Funding for most of the former programs has been included under **Utility Technologies**, which was allocated $150.6 million of the $195.3 total proposed for Solar and Other

Renewable Energy in FY 1992. (DOE's budget justification apportions funding under both of the program structures for purposes of comparison.)

Under the old structure the FY 1992 funding level would allow modest growth for **Photovoltaic**, **Biofuels**, **Wind**, and **Electric Energy Systems**, and the **Solar Energy Research Institute**. The remainder of the former programs under this account would receive cutbacks.

Under the new structure, the remaining categories include: the **Transportation Sector** program, whose chief aim is to develop biomass-based alcohol fuels to serve as an important source of alternate liquid transportation fuels; the **Industry Sector**, whose focus is the development of technologies that use solar energy in industrial processes. This category incorporates funding from the former thermal and biofuels program elements; the **Buildings Technologies** program, whose objective is to develop solar heating technologies for buildings; and **Technical and Financial Assistance,** which contains the former International and Technology Transfer Programs.

Nuclear Energy R&D

Nuclear Energy R&D would grow 28.6 percent to $381.8 million under the proposed 1992 request. The $84.8 million in new money is the largest growth proposed for any Energy Supply program.

The **Light Water Reactor** would receive $62.5 million in FY 1992, an increase of 62.3 percent over the FY 1991 appropriation. This level of funding would support work toward making the technology marketable by the mid-1990s and in use by the beginning of the next century. Funds for a second reactor program, the **Advanced Reactor R&D** program would be cut back by 13.2 percent for a total of $49.5 million in FY 1992.

Space nuclear power programs would receive a total of $142 million, representing an increase of

$33 million over the FY 1991 level. Most of the increase is due to the $30-million **Space Exploration Initiative**, a new joint program with NASA that will develop advanced propulsion technologies and systems for future Moon and Mars Exploration. **Space Reactor Power Systems** would also grow, from $33.5 million in FY 1991 to $56 million in FY 1992. Funding for the **Advanced Radioisotope Power Systems** is scheduled to fall 25.8 percent to $56 million. Among other things, this program supports NASA's Comet Rendezvous Asteroid Flyby (CRAF) and Cassini missions.

Facilities would receive $35.3 million of the new money, bringing the total to $127.8 million in 1992. This growth reflects an emphasis on public and environmental safety of nuclear facilities.

Environment, Safety, and Health

The FY 1992 budget proposal transferred the Epidemiology program and Radiation Effects Research Foundation from Biological and Environmental Research to the Environment, Safety, and Health account. Support for this program would increase from $25.2 million in FY 1991 to $37.9 million in FY 1992.

Biological and Environmental Research

A total of $306 million is proposed for this program, resulting in a 21.1-percent decrease from the FY 1991 level. Part of the decrease is explained by the transfer of the Epidemiology and the Radiation Effects Research Foundation to the Assistant Secretary for Environment, Safety, and Health. The remaining Health Effects R&D programs under this account would be cut back by about $3 million. The FY 1992 budget includes an additional $9 million for Carbon Dioxide Research, which includes the Department's contribution to the government-wide initiative on Global Change. Funding for the Human Genome Project is proposed to grow by $11.2 million in FY 1992, while the remaining elements within General Life Sciences would receive an additional $2.8 million.

Magnetic Fusion

The proposed budget for Magnetic Fusion in FY 1992 is $329.6 million, representing an increase of 22.9 percent over the FY 1991 level. Although the proposed growth is relatively large, it barely makes up for cuts Congress made in the program last year.

The FY 1992 funding request contains $41 million to begin the first year of engineering activity of the International Thermonuclear Experimental Reactor (ITER). This corresponds to DOE's decision to enter into an agreement with Japan, the Soviet Union, and the European Community to carry the ITER to completion. The principal thrust of the Magnetic Fusion program will be to prepare the Princeton Tokamak Fusion Test Reactor for Deuterium Tritium experiments and to proceed with the Burning Plasma experiment. In addition, the funding level will support the Civilian Inertial Fusion Effort.

Basic Energy Sciences

Basic Energy Sciences provides direct support for some 4,000 individual investigators at over 200 institutions, including universities and seven of DOE's major user facilities. Under the FY 1992 plan, this program would increase by just $1.5 million to $707.2 million, which fails to keep up with inflation. This level of funding would support about 1,300 individual research projects, 100 less than proposed last year.

The only notable growth in this program is planned for **Applied Mathematical Sciences** as part of DOE's contribution to the government-wide initiative on High Performance Computing and Communications (HPCC). This program is slated to receive $75.5 million, an increase of $22.8 million over the FY 1991-enacted level. **Capital Equipment and Construction** would also increase by $5.8 million to cover costs for upgrading instrumentation, equipment, and facilities.

The remainder of the programs are proposed at or below FY 1991-enacted levels. **Advanced Energy Projects** would be cut in half, from $24.9 million to $10.8 million, and **Material Sciences** would be cut by $17.8 million to $257 million in FY 1992.

Energy Research Analyses

The Energy Research Analyses program supports peer reviews of ongoing projects and independent technical assessments of DOE's energy R&D programs. A total of $4 million is requested for this activity in FY 1992, up 7.6 percent from last year's enacted level. The bulk of the funding supports assessments in Fossil Energy, Conservation and Solar Renewables, and Energy Research Areas. A small share of funding supports the National Acid Precipitation Assessment Program (NAPAP).

University and Science Education

DOE is the lead agency for the government-wide initiative on Human Resources and Education. Like last year, the agency's University and Science Education program is a high priority in the FY 1992 budget proposal. Overall, this program is slated to receive $48.9 million in FY 1992, representing an increase of 4.9 percent over FY 1991. Support for all but one of the five program elements -- University Programs -- would grow in 1992. The bulk of the new money would go to the Laboratory Cooperative Science Centers and R&D Laboratory Technology Transfer. The growth proposed for the cooperative centers (totaling $27.6 million in FY 1992) would be used to augment support for faculty and student appointments and increase the number of participants in precollege education programs at DOE labs. The proposed funding for technology transfer would expand support for Cooperative Research and Development Agreements at DOE multiprogram laboratories.

II. FOSSIL ENERGY R&D

Fossil Energy R&D is under fire again. Mirroring previous budget requests, the FY 1992 proposal more than halves this program, which supports R&D on advanced technologies for cleaning coal, improving coal-based power systems, and extracting gas from elusive sources. Overall the Fossil Energy R&D program would receive $181.7 million in FY 1992, down from the FY 1991 enacted level of $387 million.

No program element is spared this year. All are cut by 50 percent or more, with the exception of **Petroleum**, which is slated to fall 11.5 percent. Funding for **Coal** research would be slashed by 60.2 percent, and fall from a FY 1991 level of $289.1 million to $115.0 million in FY 1992. Every area of research on coal would be cut, and funding for studies of advanced physical and chemical techniques for clean coal products eliminated. The reduced budget for **Petroleum** research includes bolstered support of R&D on more powerful extraction technologies. The request also eliminates all of the existing elements under **Gas**, and proposes a new industry cost-share program in an attempt to reduce the federal burden in unconventional gas recovery.

III. ENERGY CONSERVATION

For a second year in a row, the Administration has proposed significant growth for Energy Conservation programs. This year, the budget request contains $278.7 million for this account, an increase of 27.2 percent over FY 1991-enacted levels. This program has been reorganized to include the same sector-derived categories as in Solar and Renewable Energy. Because the new categories are very similar to the former programs, the following discussion reflects the FY 1992 proposal for the new structure only.

The budget request provides relatively substantial increases for all Energy Conservation programs. The largest program, **Transportation Technologies**, is slated to receive $107.7 million in FY 1992, representing an increase of $26.7 million above the comparable level for FY 1991. This program includes efforts to develop advanced fuel-saving technologies, such as electric vehicles and ceramic engines. A total of $99 million is proposed for **Industrial Technologies**, which allows for a $18.1-million increase above the comparable FY 1991 level. This program's chief objective is to improve efficiency in energy-intensive industrial processes and reduce industry's reliance on oil. The **Buildings Sector** is slated to receive $50.3 million in FY 1992, up 27.5 percent over the FY 1991 comparable level. The chief aim of this program is to develop commercial solar technologies that would assume 25 percent of the energy requirements of new buildings in the near term.

IV. GENERAL SCIENCE AND RESEARCH

About a fifth of the Department's R&D budget is allocated to General Science activities, which include High Energy Physics, Nuclear Physics, and the Superconducting Super Collider. Although the budget request includes $393.8 million in new money for this account (a 34.6 percent increase), the SSC gets the lion's share -- $286.9 million.

High Energy Physics

High Energy Physics would claim $666.4 million of the General Sciences allocation in FY 1992, up 13.2 percent from the FY 1991-enacted level. This amount contains $150.4 million for basic physics research and $275.7 million for operation of the three DOE high energy physics laboratories: Fermi National Accelerator Laboratory (Fermilab); Stanford Linear Accelerator Center (SLAC), and Brookhaven National Laboratory (BNL). Funding in the FY 1992 request would also be used to expand the high energy physics technology base, upgrade facilities and accelerators, and to complete construction of the

Fermilab Linac Upgrade. In addition, the budget includes funding to initiate construction for the Main Injector, a replacement accelerator that will enhance the power of Fermilab's superconducting Tevatron injector.

Nuclear Physics

This program supports basic research in the fundamental properties and characteristics of atomic nuclei and nuclear matter. The Administration's FY 1992 request for this program is $342.4 million, an increase of $29.1 million (or 9.3 percent). About half of the new money is distributed among the four research areas: medium energy, heavy ion, and low energy nuclear physics and nuclear theory. Construction projects would receive $89.2 million in FY 1992, with the Relativistic Heavy Ion Collider receiving over half of these funds. Support for the construction of the Continuous Electron Beam Accelerator Facility would fall from the enacted level of $58.5 million to $31.8 million in FY 1992.

Superconducting Super Collider

Growth proposed for General Science programs, or for that matter energy programs in general, pale in comparison to the $286.9-million increase requested for the SSC. The additional funds would bring the SSC's funding level to $522.7 million in FY 1992, a 121.7-percent increase over the FY 1991 appropriation. This proposed funding would enable construction of the first segment of the tunnel to begin by 1992. The Department of Energy estimates the total cost to be $8.2 billion, which is at the low end of the cost estimates the Department received last summer. The target date for completing the project is 1999.

V. ATOMIC ENERGY DEFENSE ACTIVITIES

The nuclear component is a major mission of the Department of Energy, and at a level of almost $3.2 billion in FY 1992, commands by far the largest share of R&D funds at the Department. AEDA's share is shrinking, however. Last year's budget request for AEDA accounted for 42.6 percent of DOE R&D funding; AEDA's share has slipped to 39.5 percent this year. The FY 1992 budget request for AEDA programs would provide an increase of 5.5 percent over last year's appropriation.

Over half of the AEDA total -- some $1.8 billion -- would go to **Weapons R&D and Testing**, an increase of $26.9 million or 1.5 percent. This program supports the Energy Department's core nuclear weapons complex and research on the Inertial Fusion program. Funding for associated facilities would also increase in FY 1992 as part of the Department's effort to improve safety of nuclear weapons.

One of the largest percentage increases occurs in the **New Production Reactor** program, whose objective is to provide a safe and environmentally sound production reactor capability of nuclear materials (primarily tritium). This program would rise from $349.9 million in FY 1991 to $441.2 million in FY 1992, representing an increase of 26.1 percent.

Verification and Control Technology would go up 25.2 percent to $83.4 million in FY 1992. The request provides for an enhanced level of detection development technology, treaty implementation, and continued construction of the Center for National Security.

VI. URANIUM ENRICHMENT

The Uranium-Atomic Vapor Laser Isotope Separation (U-AVLIS) program, DOE's uranium enrichment R&D activity, would grow by $59.1 million to $213.6 million under the FY 1992 plan. The principal objective of the program is to design an enrichment technology that is lower in cost than the existing gaseous diffusion plants or technology available from foreign competitors. The FY 1992 request augments FY 1991 funding for nearly all program elements, especially Lasers and Systems Integration. The proposed budget would enable the program to demonstrate the laser enrichment technology on schedule late in FY 1992.

VII. CLEAN COAL TECHNOLOGY

The FY 1992 request for Clean Coal Technology is $290 million, a drop of $76.0 million, or 20.8 percent, from the FY 1991 enacted level. This program, begun in 1986, provides funding on a cost-shared basis to design technologies that improve the efficiency of coal-burning plants, decrease the adverse environmental impacts, and provide new forms of coal that would serve as lower-cost substitutes for gas and oil. The decline in funding results from the shift of several ongoing projects from the R&D phase to construction and demonstration phases.

VII. ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

Environmental Restoration and Waste Management is one of the highest growth components of the FY 1992 proposal. The Department established the Environmental Restoration and Waste Management Five-Year Plan, which is the cornerstone of the Department's long-term strategy to consolidate the environmental cleanup of its facilities. The Plan consolidates cleanup activities in DOE's defense, nuclear energy, and energy research programs into one program with a unified agenda.

The request calls for a $124.3 million increase in funding for this program, bringing the total to $330.3 million in FY 1992. The budget proposal would support efforts to prevent near-term adverse health and environmental impacts and bring facilities into compliance with regulatory standards.

Chapter 9

NASA in the FY 1992 Budget

American Institute of Aeronautics and Astronautics

Joanne Padron

Highlights

- The proposed FY 1992 budget for NASA is $15.754 billion. This is more than $1.885 billion higher than the FY 1991 current estimate, reflecting a 13.6 percent increase and approximately 1 percent of the entire FY 1992 federal budget.

- The proposed Space Station budget estimate is $2.028 billion, representing a modest increase of 6.78 percent over the current estimate of $1.9 billion. This reflects NASA's efforts to comply with the Congressional mandate set in November 1990 to remove $6 billion from the program's budget over the next five years.

- NASA is proposing to begin work on a major joint DOD program to develop a new heavy-lift booster to supplement the Shuttle. The program reflects a redefinition of the NASA/DOD Advanced Launch System project and is unlikely to pass Congress unchallenged.

- A second new initiative proposed in the FY 1992 request is the Lifesat project. Lifesat is part of the Radiation Biology Initiative which will address the effects of space radiation on living things.

- The Space Exploration Initiative which received considerable focus last fiscal year after President Bush's Apollo anniversary speech, and which was given no budgetary support from Congress, received a more restrained request ($94 million) from the Administration in FY 1992.

Research and Development

The objective of NASA's research and development (R&D) program is "to extend our knowledge of the Earth, its space environment, and the universe; to expand the technology for practical applications of space technology; to develop and improve manned and unmanned space vehicles; and to assure continued development of the long-term aeronautics and space research and technology necessary to accomplish national goals." NASA's R&D program is divided among the following:

Space Station

In the Conference Report that was released with the FY 1991 HUD-VA-Independent Agencies Appropriation Bill containing NASA's budget, Congress mandated that $6 billion be removed from the Space Station Freedom funding over the next five years and that NASA revise the design and assembly sequence to fit these constraints. The funding requested for FY 1992 is $2.028 billion, reflecting a modest increase of $128 million (6.78 percent) from FY 1991.

Because of the Congressional mandate, Space Station Freedom is undergoing a restructuring of the design and schedule. At the time this chapter was being prepared, the new station plan was scheduled to be released in early March.

Due to the restraints of the restructured program, the Flight Telerobotic Servicer (FTS) is being transferred from the Office of Space Station to the Office of Aeronautics, Exploration, and Technology. Funding for the development of the FTS will be transferred into a new budget line item under Space Research and Technology in FY 1992.

Space Transportation Capability Development

This area received the second largest increase of all of the R&D programs, growing from $602 million to $879 million (46 percent). This request for increased funding is largely attributable to the New Launch System program which replaces two separate efforts from FY 1991, the Advanced Launch System (ALS) and Shuttle-C. The New Launch System program is the direct result of the key recommendation made by the Advisory Committee on the Future of the U.S. Space Program to develop "an evolutionary, unmanned but man-rateable, heavy-lift launch vehicle." Like ALS, the New Launch System program will continue as a NASA/DOD joint project. A budget request of $175 million has been proposed by NASA, a huge leap from the $23 million estimate of FY 1991.

The Orbital Maneuvering Vehicle (OMV) was deleted in the FY 1991 appropriations legislation and NASA is in the process of completing the termination requirements.

Space Science and Applications

Funding requested in this area was increased $505 million (21 percent) to $2.934 billion. The program is divided into seven subcategories:

- Physics and Astronomy -- increased $165 million to $1.140 billion (17 percent). This includes $2 million for research in predicting solar flares and cosmic ray fluctuations. This line item is one of the elements of the Space Exploration Initiative (SEI) and will help increase our knowledge of radiation exposure during long-term missions. Funding is also included in FY 1992 to begin the initial design of the Advanced X-Ray Astrophysics Facility.

- Life Sciences -- increased from $138 million in FY 1991 to $183 million in FY 1992. This includes funding for Lifesat to move from the mission studies phase to the development phase. Lifesat is part of the Radiation Biology Initiative and is a reusable re-entry satellite which will research the effects of radiation to living specimens.

  An augmentation of $10 million was also requested to conduct studies in artificial gravity, planetary protection, advanced remote medical care, and human factors for precursor and human Lunar-Mars missions. This proposed study as well as the Lifesat project are a part of the SEI program and represent NASA's continued interest to better understand the effects to humans of long-term missions in space.

- Planetary Exploration -- increased 37 percent, from $457 million to $627 million. Funding for the Comet Rendezvous Asteroid Flyby (CRAF)/Cassini mission continues to grow significantly with a proposed budget of $328 million in FY 1992, more than double the FY 1991 current estimate. The request in FY 1992 is to continue the design and development of the spacecraft.

  Funding was also requested to complete the spacecraft development and instrument integration of the Mars Observer program which is scheduled to be launched in September 1992. The program's objective is to complement the data acquired from the Mariner and Viking missions, and although the orbiter will provide needed information for the SEI, NASA has not tagged it as part of the initiative.

- Earth Science and Applications -- was increased almost $108 million to $775.6 million in FY 1992. With the continued public interest in the environment this remains a favorite program with Congress and received one of the few increases to the Administration's proposed funding level in FY 1991. By far the largest portion of the Earth Science and Applications subcategory is taken up by the Earth Observation System (EOS) which received $253 million in FY 1992. EOS will utilize a series of polar orbiting platforms to study the Earth's environment.

- Materials Processing - increased by $23.5 million (23 percent) to $125.8 million.
- Communications - decreased $13 million to $39 million (25 percent). This includes funding for the Advanced Communications Technology Satellite (ACTS) which is scheduled for launch in FY 1992.
- Information Systems - increased 14 percent to $42 million. This program provides the advanced data systems to support NASA's space science and applications flight and research projects.

Commercial Programs

Commercial Programs received a 74 percent increase from the Administration in FY 1992 growing from $86 million to $150 million. Commercial Programs is separated into two subcategories:

- Technology Utilization - increased $7.6 million to $32 million. This subcategory is set up to assist the transfer and application of aerospace technology to the public and private sectors.
- Commercial Use of Space - increased 92 percent to $118 million in FY 1992. This program includes funds for the Commercial Experiment Transporter (COMET) which will provide long-duration exposure for microgravity payloads on an expendable launch vehicle. It also supports the

lease of a commercially provided payload module which will provide pressurized man-tended capability onboard the Shuttle.

Aeronautics and Space Technology

Requested funding in this area increased from $897.4 million in FY 1991 to $1.085 billion in FY 1992. This area is divided into only three subcategories in the new fiscal year with the Exploration Mission Studies subcategory created in FY 1991 being transferred into Space Research and Technology. This transfer reflects the hesitant interest by Congress to jump on the Administration's bandwagon and return a human to the Moon and/or Mars.

- Aeronautical Research and Technology - increased $79.2 million (15 percent) to $591 million. Funding in this area includes a request of $17 million for the creation of a new multi-agency program entitled High-Performance Computing and Communications (HPCC). HPCC is NASA's implementation of its portion of the Administration's plan for "The Federal High-Performance Computing Program."

  High-Speed Research was increased by $32.4 million to $76.4 million. Funding in this area will be used for the High-Speed Civil Transport (HSCT) program and will continue to address the environmental issues needed before some of the technology development aspects of the program are continued. The new fiscal year will also focus on advanced material systems such as ceramic composites and intermetallic composites.

- Transatmospheric Research and Technology - decreased by $23 million (24 percent) to $72 million. This joint NASA/DOD program to develop the National Aero-Space Plane (NASP) was given a lower budget request in FY 1992 because of a recommendation by the National Space Council to extend the technology development phase of the program. In 1990 the competing NASP prime contractors formed a consortium and will work with other government agencies to continue efforts in the areas of vehicle-concept and technology development.

- Space Research and Technology - increased $131 million (45 percent) to $421.8 million. The goal of this area is to provide advanced, enabling technologies for future space missions.

The Exploration Technology Program received a $52 million request from the Administration. This program advances critical technologies in the areas of manned and robotic missions and is an element of SEI. A portion of the budget request includes funds for a joint NASA/DOD/DOE program to begin technology research in nuclear propulsion. Nuclear propulsion will play a key role in any future human exploration missions beyond lunar orbit, such as Mars.

A new line item in this area is the Space Automation and Telerobotics Technology Program. This program includes the Flight Telerobotic Servicer (FTS) project, and telerobotics and artificial intelligence programs which were previously part of the Space Station and CSTI programs, respectively.

Exploration Mission Studies received a request of $15 million, a modest sum compared to the $37 million requested by the Administration for FY 1991. In FY 1991 NASA initiated an Outreach Program which was chartered to formulate exploration architecture options and assess enabling technologies for SEI. A Synthesis Group was formed to integrate the results of the Outreach and provide recommendations to NASA. Funding in FY 1992 will be used for a more in-depth analysis of the architectures and technologies identified by the Group.

Chapter 10

R&D in the Department of Agriculture

National Association of State Universities and Land-Grant Colleges

James W. Cowan, Elizabeth Allred

The FY 1992 Research and Development budget proposal for the Department of Agriculture is $1,352.6 million. This request represents a one percent increase from the FY 1991 current estimate of $1,349.1 million. The totals (in millions of dollars) by agency for the FY 1991 current estimate and the FY 1992 Executive Request are:

	Current Estimate FY 1991	Executive Request FY 1992
Agricultural Research Service (ARS)	672.5	716.7
Cooperative State Research Service (CSRS)	454.2	409.2
Economic Research Service (ERS)	54.8	62.9
Forestry Service (FS)	167.6	163.8
Total R&D, USDA	1,349.1	1,352.6

USDA has several major initiatives which cut across agency boundaries and seek to satisfy research needs in Food Safety ($59.3 million), Water Quality ($79.8 million), Global Change ($52.1 million), National Research Initiative ($125 million).

The Food Safety Initiative proposes a $9.1 million increase for additional research in ARS and CSRS. Further work is needed in creating a scientific basis for operating testing programs. There is also the need to develop improved techniques for rapid pesticide residue detection. Other research activity will focus on the development of production systems and processes to control salmonella and other microbiological contaminants and mycotoxins in food grains, feed grains, milk, meat, poultry and eggs. A proposed increase of $1.2 million in ERS would be implemented in conducting research on the economics of food safety.

Water Quality research remains an important focus of USDA and receives a proposed increase of $2.8 million for federal and university research programs. Projects will continue in the Midwest Corn Belt on the use of nitrogen and pesticides in connection with conservation tillage practice in corn and soybean production. Research activity will include: assessment of role of wetlands and stream borders in modifying the movement of chemicals into water; development of crop rotation systems and means to use animal wastes to maintain and improve water quality without sacrificing profitability; and improvement of understanding of transport and deposit of agricultural chemicals in soils and water.

More research is needed on Global Change and the Administration requests a $13.5 million increase for federal scientists in ARS, ERS and FS and competitive grants to universities through CSRS. Priorities for 1992 include: better understanding of carbon cycle; development of basic hydrologic models to understand the effects of global change on water availability at local, watershed and regional levels; forestry research which emphasizes forest ecosystem dynamics, with special emphasis on carbon cycle relationships. Current programs on soil and water research, survey programs and research which supports development of crop plants better able to withstand climate extremes will continue.

The Administration continues its commitment to the National Research Initiative (NRI) with a request of $125 million for all six research areas. This represents an increase of $52 million over the FY 1991 level of $73 million and an addition of two research categories (see details in CSRS table below).

Agricultural Research Service (ARS)

The proposed budget for ARS, the primary research agency in USDA, is $716.7 million, a six percent increase over the current estimate for FY 1991. ARS will continue to promote agricultural research that is environmentally sensitive and to support the development of new knowledge to respond to critical issues in food safety. Increases are also proposed for research on new biological controls and pilot-test integrated pest management strategies (+$2.5 million), development of systems to integrate animal wastes into crop production (+$1 million), alternative fuels, and an increase (+$2 million) to expand research to improve the conversion of biomass to alcohol fuels.

ARS RESEARCH PROGRAMS
(in millions of dollars)

Program	Current Estimate FY 1991	Executive Request FY 1992
Soil and Water Conservation	83.4	95.4
Plant Sciences	232.9	243.6
Animal Sciences	110.0	114.2
Commodity Conversion/ Delivery	118.3	129.7
Human Nutrition	49.6	50.0
Integration of Ag'l Systems	11.5	11.9
Buildings and Facilities	41.0	46.1
Repair and Maintenance	17.4	17.4
Contingency	0.9	0.9
Trust Fund	7.5	7.5

Cooperative State Research Service (CSRS)

CSRS administers federal funds provided for research at the state agricultural experiment stations and other eligible institutions. The agency also participates in the nationwide system of research planning and coordination. The proposed budget for FY 1992 of $409.2 million is a ten percent decrease from the FY 1991 current estimate of $454.2 million. It should be noted, however, that this decrease mostly represents the lack of request in the Administration's budget for special research grants which are traditionally appropriated at the discretion of Congress. Program funding (Hatch Act) for agricultural research at the land-grant institutions increases by almost four percent to $168.3 million. The Hatch Act ensures a continuous base of on-going research needs. This base is complemented by a competitive grants programs, the National Research Initiative (NRI). The NRI seeks to respond to needed agricultural research in six broad areas which are listed below. USDA also proposes for FY 1992 an Agricultural Research Facilities Program that would seek to build up current capabilities at universities nation-wide. This program is for competitive, matching grants.

CSRS RESEARCH PROGRAMS
(in millions of dollars)

Program	Current Estimate FY 1991	Executive Request FY 1992
Hatch Act	162.3	168.3
Cooperative Forestry Formula	17.8	13.0
1890 and Tuskegee	26.3	27.3
Animal Health (sec. 1433)	5.6	0.0
Competitive Grants/ National Research Initiative		
Plant Systems	35.0	53.0
Animal Systems	20.0	30.0
Nutrition, Food Quality and Health	4.0	13.0
Natural Resources and Environment	14.0	23.0
Processes and New Products	0.0	4.0
Markets, Trade and Policy	0.0	2.0
Special Research Grants	62.4	26.7
Higher Education	7.5	5.5
Morrill-Nelson Act	2.8	0.0
Critical Ag Materials	0.8	0.0
Aquaculture Research Centers	3.8	0.0

CSRS RESEARCH PROGRAMS (cont'd)
(in millions of dollars)

Program	Current Estimate FY 1991	Executive Request FY 1992
Alternative Crops Research	1.2	0.9
Low-input/sustainable ag	6.7	4.5
International Trade Centers	3.2	0.0
Federal Administration	9.6	2.0
Buildings and Facilities	62.9	25.0*

*Proposed Agricultural Research Facilities Competitive Grants Program

CSRS RESEARCH GRANTS
(in millions of dollars)

Special Grants	Current Estimate FY 1991	Executive Request FY 1992
Integrated Pest Mgmt	4.0	5.0
Pesticide Clearance	3.0	3.0
Minor Use Animal Drug	0.5	0.5
Pesticide Impact Assessment	3.0	3.0
Rural Development Ctrs	0.5	0.0
Aquaculture Research	0.6	0.0
Tropical/Subtropical Ag	3.3	0.0
Biological Impact Assessment	0.3	0.3
Water Quality	8.0	10.0
Special Problem Grants	38.7	0.0

CSRS RESEARCH GRANTS (cont'd)
(in millions of dollars)

Competitive Grants	Current Estimate FY 1991	Executive Request FY 1992
Natural Resources and Environment	14.0	23.0
Nutrition, Food Quality and Health	4.0	13.0
Plant Systems	35.0	53.0
Animal Systems	20.0	30.0
Processes and Developing New Products	0.0	4.0
Markets, Trade and Policy	0.0	2.0

Economic Research Service (ERS)

ERS performs economic and other social science research, outlook forecasting and policy analysis related to U.S. and international agriculture, food, production resources and rural America. The FY 1992 budget proposal of $62.9 million is an increase over the 1990 current estimate of $54.8 million. ERS is requesting increases for its food safety and pesticide assessment activities. Such increases would help ERS to maintain the focus set by USDA in general on food safety issues. Increases are sought in Water Quality to expand data collections and economic and policy analysis for research, education, technical assistance and pesticide benefit-cost and risk assessments.

Forest Service (FS)

Research in FS is conducted and disseminated through eight regional forest experiment stations and the Forest Products Laboratory and includes both in-house and extramural programs. The FY 1991 budget request of $163.8 million is a decrease from the FY 1991 current estimate of $167.6 million. Funding levels for research will continue with very little increase. Real increases are requested in global change research and tropical forestry research.

Chapter 11

R&D in the Environmental Protection Agency

American Association for the Advancement of Science

Kathleen M. Gramp

Highlights

- The President has requested $491.3 million for R&D in the Environmental Protection Agency (EPA) in FY 1992, 8.7 percent more than the $452 million available this year. This is slightly below the 9.9 percent growth proposed for EPA's other operating programs.

- EPA's R&D provides scientific guidance for agency policies and regulations. Most of the research remains focused on specific "media" issues, such as air quality, but a growing share supports basic research on ecological systems and human health. Basic research would account for about 24 percent of EPA's FY 1992 R&D effort, up from 7.5 percent five years ago.

- The increases would be spread unevenly. All of the "media" programs would enjoy higher funding, ranging from a 29.8 percent gain in air quality R&D to a 0.4 percent increase in the acid rain program. The budget keeps a lid on funding for the two trust funds, cutting Superfund R&D by 6.8 percent and capping R&D on Leaking Underground Storage Tanks (LUST) at the FY 1991 level.

- EPA would channel much of the new money into monitoring and characterization research, largely because of new mandates in the Clean Air Act Amendments of 1990 (funding would rise 37.8 percent). Other areas of concentration include ecological research (up 20 percent) and global change (up 27.6 percent).

- EPA is increasingly involved in interagency R&D. It is spearheading the "ecological monitoring and assessment program," (EMAP, under multi-media and Great Lakes) and an agricultural pollution effort (under drinking water and pesticide R&D). EPA also plans to support the government's high performance computing initiative (under multi-media). Another new priority is research on electromagnetic radiation (under radiation R&D).

- At Congress' direction, EPA now funds part of its intramural R&D through the "Research and Development" appropriation (which had been extramural money) instead of "Salaries and Expenses" (which was used for intramural funding). This shift cut into extramural funding by about $24 million in FY 1991, because Congress did not increase the extramural appropriation to offset the transfer.

Tables II-16 and II-17 show how the Administration would allocate the $491.3 million by medium (e.g., air, water, hazardous waste, etc.), and by category (e.g., environmental engineering, health effects, monitoring, etc.).

Multi-Media R&D

"Multi-media" research is now the largest component of EPA's R&D budget, tapping 27 percent of the agency's FY 1991 funding. Two factors have propelled multi-media to the top of the list: rapid growth in basic research, and the inclusion of some intramural R&D support ($34.6 million in FY 1991).

The agency has requested a total of $150.7 million for this category in FY 1992, which is $27.5 million (or 22.3 percent) higher than this year's appropriation. If Congress concurs, EPA expects basic research to post year-to-year growth of over 18 percent.

This "core" research is designed to provide a scientific framework for analyzing complex and interrelated environmental issues. While most of the" media" research focuses on discrete pollutants or technologies, these studies assess risks to ecological systems and human health.

As part of this effort, the Administration has recommended $27.4 million for exploratory research grants and academic research centers. Although funding appears static, the budget provides a $3.3 million increase if Congressionally earmarked projects are deducted from the FY 1991 budget. The additional money would enable EPA to support 74 new research grants and continue 118 ongoing studies (compared to 50 new and 103 continuing grants in FY 1991). Three new academic centers would get underway in FY 1992, focusing on high priority issues such as groundwater and hazardous waste control technologies.

The Environmental Science and Engineering Fellows program would continue to support 10 professionals in various EPA offices. The overall budget for "inter-disciplinary activities" would fall from $4.9 million to $3 million in FY 1992, however, as researchers wrap-up a Congressionally mandated study.

EPA has requested $33.3 million for ecological research next year, which would add $7.9 million (or 31.2 percent) to current levels. The agency would expand the scope of its environmental monitoring and assessment program (EMAP) to include research on lakes (Lake Ontario and others in the northeast); estuaries (in the Louisianian and Virginian provinces); wetlands (in the Gulf of Mexico area); forests (in the northeast and southeast); and arid lands and agro-systems. The landscape characterization of the northeast region is nearing completion, allowing work to begin on the southeast. Funding also would support refinements to models used to assess risks to near-coastal estuaries.

Core research on health risks would receive $12.9 million in FY 1992 under the President's plan, or $1.9 million (17.8 percent) more than budgeted for this year. Researchers would examine the link between exposure and delivered dose, factoring in variations among affected populations (e.g., age, race, gender, and lifestyle) and the methods of exposure (e.g., air, food, water, skin, etc.). Models will assess risks associated with volatile organic compounds other than benzene, and biological and other high priority contaminants.

EPA also hopes to lower risks through its pollution prevention and technology transfer programs. The $5.3 million requested for "risk reduction" would support R&D on recycling and on reducing pollution from industrial, municipal and agricultural processes. EPA scientists would analyze new designs and procedures, worker training, and disposal environments. Socioeconomic research plays an important part of this effort, focusing on attitudinal change.

EPA wants to devote $10.8 million to technology transfer and liaison programs next year, 11.3 percent more than in FY 1991. Outreach activities would involve laboratory researchers, universities, governmental entities, and the business community.

Starting this year, most of EPA's R&D support functions are being consolidated into line items within the multimedia R&D appropriation. Over $42 million is included in the request for headquarters and field support in FY 1992, up from $34.6 million in FY 1991. The bulk of the $7.5 million increase would be used to replace obsolete scientific instruments and to cover rising operating expenses at EPA labs.

Finally, EPA wants to invest $3.6 million in the interagency initiative for high-performance computing. This FY 1992 contribution would enhance modeling efforts, especially in the areas of global change and acid deposition.

Global Change (Air Quality R&D)

Two of the most controversial issues facing EPA are global climate change and stratospheric ozone depletion. Citing the need for better data and analyses, the agency is asking for a total of $25.5 million in FY 1992 for R&D on these two topics, $5.5 million (or 27.6 percent) more than this year's appropriation.

Most of the increase would be dedicated to global change. Models would be developed to measure the carbon gas fluxes between the biosphere and atmosphere, taking note of the role of land use and human activity. One focus of the engineering R&D would be technologies for controlling emissions from rice paddies, which are a major source of methane. Ecological studies would examine the effects of climate change on sensitive biota.

Researchers also would assess the impact of stratospheric ozone depletion on ecosystems and human health. As part of its ongoing effort to lower emissions of clorofloröhydrocarbons (CFC's), EPA would study ways to curb losses from automobile air conditioners, recycle CFC's, and market alternatives. Replacements for halons and nitrous oxides would be pursued as well.

Other Air Quality

EPA also recommends higher funding for other air quality R&D. The $86.9 million proposed for next year represents a $20.3 million gain (or 30.4 percent) over FY 1991. (These figures exclude global change research, which is described above.)

Virtually all of this growth is for monitoring and characterization R&D mandated by the 1990 amendments to the Clean Air Act (CAAA). The $47.4 million budget for monitoring, characterization, and quality assurance (up 76 percent) would focus on five areas: nonattainment pollutants, airborne toxics, acid rain, alternative fuels, and indoor air pollution.

Specific tasks include modeling the chemistry and transport of ozone and acid aerosols, and studying particulate and visibility issues. Models would be developed on the characteristics, risks, and deposition of airborne toxic chemicals. To support new acid rain standards, EPA would refine techniques for measuring emissions and examine the industrial emissions inventory. Recent laws also call for expanded monitoring and analysis of emissions from alternative fuels for mobile and stationary sources. Finally, EPA would increase funding for diagnostic tools to gauge indoor air pollution in residences and large buildings.

Much of EPA's ongoing air research is linked to these legislative priorities. Using the $20 million proposed for FY 1992, health researchers would examine the effects of chronic exposure to key pollutants, such as ozone, acid aerosols, and sulfuric acid. Health impacts would be factored into the risk assessments of air toxics (especially urban air mixtures), and automotive emissions, including alternative fuels. To better understand the "sick building" syndrome, EPA hopes to study the health effects of combustion products (e.g., tobacco smoke) and volatile organic compounds.

Scientific assessments, funded at an estimated $7 million next year, would complement other R&D on indoor air pollution, acid aerosols, lead, and ozone. Despite a shrinking budget for engineering R&D ($10 million in FY 1992), EPA plans to investigate technologies to control SO_x volatile organic compounds, and particulates from woodstoves. Funding for ecological studies would remain level at $2.4 million, enabling ORD to study the impact of tropospheric ozone on vital forest species.

Acid Rain (Energy) Research

Last year's CAAA forged policies on acid rain that are dependent upon continued research. EPA has requested a total of $13.7 million for this R&D, an amount roughly equal to the FY 1991 budget.

The agency would allocate $10.2 million of this total for research on acid deposition. As soon as American and Canadian scientists complete their evaluation of the "Regional Acid Deposition Model" (RADM), it will be used to forecast the effects of the CAAA's new policies for emissions trading and coal moratoriums. EPA plans to make a desktop version of the RADM available in FY 1992.

At the same time, researchers will continue to improve the models and data used to measure emissions and acid deposition. Next year's agenda calls for improving estimates of emissions from area sources and maintaining models of major industrial sources. EPA also will operate and improve the network of monitoring sites.

The remaining $3.5 million would support a commercial-scale demonstration of the LIMB technology and in-house studies of full scale demonstration. Project assessments would focus on waste disposal issues.

Water Quality

Water quality research would expand under the President's plan, rising from $27.7 million this year to $28.9 million in FY 1992. In fact, the growth is higher than suggested by these figures, because of the proposed transfer of oil spill research to the hazardous waste program. Adjusting for this shift, the budget represents a 22 percent increase.

EPA would devote over half of the resources to research on ecological factors affecting ambient water quality ($15.4 million in FY 1992). Wetlands and sediment contamination top the research agenda. Supporting the agency's policy of "no net loss" of wetlands, researchers would evaluate the functions of wetlands in promoting water quality; the impacts of wetlands conversions; and ways to mitigate damage to these ecosystems. Sediment quality is coming under greater scrutiny, because of concerns about chemical and organic wastes accumulating in aquatic ecosystems.

The budget recommends that Congress more than double funding for research on the Great Lakes (to $4.6 million in FY 1992). Most of this increase would be to support additional research on exotic, non-indigenous species such as the zebra mussel. Work would continue on models of mass balance, and of the sources and distribution of toxic chemicals in the lake basins.

Other research tasks would lend support to the wetland, sediment, and Great Lakes initiatives. Environmental engineers would continue to assess the effectiveness of constructed wetlands to treat wastes. Researchers also hope to develop methods to analyze and control contaminated sediments, with a particular eye on the Great Lakes.

Drinking Water

The Administration advocates spending $22.2 million on drinking water research next year, which would add $1.5 million (or 7.3 percent) to the FY 1991 level. These estimates understate the true increase, because the $0.6 million for aquifer restoration research is classified a hazardous waste program in FY 1992.

EPA would investigate groundwater problems and solutions. A top priority is groundwater contamination from food and agricultural processes. An interagency research effort would investigate management as well as ecological factors.

The wellhead protection effort would focus on better monitoring and cleanup technologies, including in-situ restoration. Engineers also hope to find ways to purge pesticides, volatile organic compounds, viruses (Hepatitis A), and other contaminants from drinking water. In FY 1992, these studies would focus on technologies for groundwater and small public systems.

EPA scientists would continue to examine the potential health effects of disinfectants used by public systems. Many systems plan to switch from chlorinated disinfectants to ozone and chloramine even though little is known about the potential effects of their by-products.

Hazardous Waste R&D

Hazardous waste R&D could regain lost ground if Congress provides the $43.6 million proposed for FY 1992. Compared to this year's $39.2 million budget, the request appears to offer an additional $4.4 million (or 11.3 percent). This growth is overstated, however, because $2.6 million of the increase is due to a transfer of two programs from water quality R&D.

Almost half of the hazardous waste R&D budget, or $19.5 million, would be used for engineering research on waste control technologies. Funding would rise by $3.2 million under the President's request, primarily because of transfer of $2 million for oil spill research. Some scientists would focus on ways to reduce waste production, while others would continue to assess the effectiveness and impacts of land disposal and incineration facilities. EPA also would investigate bioremediation techniques for treating buried industrial wastes, and chemical and biological agents for cleaning up oil spills.

Bioremediation and oil spill technologies would also be analyzed within the $9 million proposed for ecological R&D. In addition, scientists would evaluate site assessment models to support the agency's permitting process. This line item includes $0.6 million for aquifer restoration research, which EPA is transferring from the water research program.

Funding for monitoring techniques would inch up to $9.7 million next year. EPA plans to develop and refine methods of detecting organic contaminants in the air and toxic wastes in the soil. Remote sensing technologies would be used to verify information given to EPA under permits, and to monitor spills. Researchers also would work on "microcosm" models to help tailor oil spill clean-up techniques to particular ecosystems.

Superfund Research

Judging from the numbers, Superfund R&D is the only medium slated to receive less money in FY 1992. If the Congressionally earmarked funds are deducted from the current level, however, the trend is reversed. Assuming that adjustment, Superfund's $68.6 million research budget represents about a 5 percent increase.

Most of the budget juggling affects the $29.5 million requested for engineering R&D. It falls $5.3 million short of the current appropriation, but exceeds the FY 1991 level if earmarks for the Gulf Coast Research Center and the Montana Mining Waste program are taken out of the equation.

EPA has reordered its engineering priorities, proposing to shift resources from the Superfund Innovative Technology Evaluation program (SITE) to Superfund Technical Assistance Response Teams (START). The SITE program will continue to evaluate promising technologies, but at a slower pace (down from ten field tests and eight new projects annually). EPA needs the money to meet the rising demand for technical assistance from government officials involved in emergency and remedial actions.

Much of the $11.7 million requested for monitoring research also would be applied to practical problems. Project managers need techniques to quickly and accurately assess the hazards at Superfund sites. Researchers would help regional staff evaluate specific sites and agreements, by providing methods and technical assistance for interpreting aerial, water, and subsurface data.

Scientists would also help field staff by doing chemical and site-specific risk assessments, and by ranking the carcinogenic and health effects of reported chemicals. The $4.2 million budget for scientific assessments would also enable researchers to prepare the health effects component of Superfund studies.

While the bulk of the Superfund R&D directly supports operations, about $9.3 million would be available for exploratory research. This status quo budget is expected to support approximately six new research grants (targeted on "pump and treat" technologies), and maintain the current Hazardous Substance Research Centers. The Small Business Innovative Research program would solicit ideas on pollution prevention and control.

Funding for ecological research would remain level, receiving $7.3 million under EPA's plan. Scientists would continue to study the physical, biological, and chemical processes involved in bio-remediation and "pump and treat" techniques.

Pesticides Research

For the fourth year in a row, the Administration is asking Congress to increase funding for pesticide research by about 20 percent. If, for a change, lawmakers go along with the proposal, the pesticide R&D budget would total $15 million in FY 1992 (up $2.4 million). These studies support EPA's statutory review of pesticide registration, marketing, and use.

About $1.1 million of the new money would be dedicated to health research (for a total of $4.3 million). Scientists would determine how the immune system's sensitivity to pesticides varies with age, and investigate the link between fetal susceptibility and maternal health. Ongoing areas of research include monitoring of microbial pesticides in mammalian cells; estimating the dermal absorption of pesticides; and assessing risks to humans based on animal toxicity studies.

The other $1 million add-on would support better monitoring and quality assurance (bringing the total up to $2 million). EPA wants to improve techniques for gauging human exposure to household pesticides, including risks to infants and toddlers. The budget also includes funds to monitor agricultural pesticides in ground and surface waters.

Even with level funding ($8.2 million), ecological studies would be the largest focus of pesticide R&D. Next year EPA hopes to develop predictive models of pesticide transport and fate in land, marine, and freshwater organisms. The budget also would support continued assessments of the effects of microbial pest agents, altered microbial pest control agents (MPCA's) and genetically altered biological control agents (BCA's).

To promote the statutorily-mandated recycling program for pesticide containers, EPA would provide methods for testing the effectiveness of clean-up technologies. Scientists also help state and federal regulators review pesticide treatment and disposal methods.

Radiation Research

The controversy about the health effects of electromagnetic radiation (EMR) has been added to EPA's research agenda. Studies are getting underway this year, thanks to a Congressional directive providing $750,000. EPA has requested $935,000 for EMR research in FY 1992.

The EMR researchers would evaluate which exposure conditions and mechanisms promote or induce adverse health effects. To help measure the health hazards associated with EMR, scientists would quantify dose-response relationships.

EPA is asking for an additional $3 million for other radiation R&D. About $2.9 million would be used to study radon mitigation strategies. Work would continue to focus on techniques for schools, particularly on sub-slab suction and building pressurization. The remaining $0.2 million would pay for EPA monitoring of radiation at various federal installations.

Leaking Underground Storage Tank (LUST) Research

Funding for engineering studies related to LUST sites would remain unchanged at $0.8 million in FY 1992. Researchers would evaluate above-ground and subsurface treatment technologies; document case studies; monitor releases; and assist in site assessments.

Agency Tables

Table II-1. R&D in the FY 1992 Budget by Agency in Current Dollars (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92	
				Current $	Constant $
Conduct of R&D					
Defense (Military)	$37,261.0	$36,066.0	$40,474.7	12.2%	7.8%
National Aeronautics and Space Administration	6,481.2	7,271.3	8,601.7	18.3%	13.6%
Energy	5,994.8	6,161.3	6,366.3	3.3%	-0.8%
Health and Human Services	8,432.5	9,269.6	9,831.8	6.1%	1.9%
National Institutes of Health	(7,138.0)	(7,713.8)	(8,251.8)	7.0%	2.8%
National Science Foundation	1,668.3	1,828.0	2,112.0	15.5%	11.0%
Agriculture	1,108.2	1,224.1	1,261.4	3.0%	-1.0%
Interior	510.6	584.1	561.9	-3.8%	-7.6%
Transportation	328.6	407.1	434.9	6.8%	2.6%
Environmental Protection Agency	424.2	432.8	491.3	13.6%	9.1%
Commerce	437.4	516.5	538.0	4.2%	0.1%
Nuclear Regulatory Commission	108.8	114.8	125.5	9.3%	5.0%
Veterans Affairs	215.7	219.1	219.2	0.0%	-3.9%
Agency for International Development	374.5	385.0	412.6	7.2%	2.9%
Labor	27.9	27.8	32.1	15.5%	10.9%
Education	161.5	193.2	217.7	12.7%	8.2%
Tennessee Valley Authority	56.9	66.7	67.0	0.4%	-3.5%
Smithsonian	95.0	106.0	112.0	5.7%	1.5%
Housing and Urban Development	19.7	28.7	34.0	18.5%	13.8%
Corps of Engineers	34.7	42.5	61.2	44.0%	38.3%
Justice	37.6	39.2	44.1	12.5%	8.1%
Treasury	23.6	26.0	26.4	1.5%	-2.5%
TOTAL Conduct of R&D	$63,802.9	$65,009.9	$72,026.0	10.8%	6.4%

Table II-1. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change, FY 1991-92 Current $	Percent Change, FY 1991-92 Constant $
Facilities					
Department of Energy	$1,043.1	$1,198.9	$1,623.1	35.4%	30.0%
Defense (Military)	608.1	461.3	537.6	16.5%	12.0%
National Aeronautics and Space Administration	630.4	856.6	885.0	3.3%	-0.8%
Agriculture	115.1	155.8	128.4	-17.6%	-20.8%
Health and Human Services	100.4	185.8	129.9	-30.1%	-32.8%
National Institutes of Health	(77.3)	(175.5)	(121.1)	-31.0%	-33.7%
National Science Foundation	60.5	92.2	129.9	40.9%	35.3%
Transportation	25.1	18.2	28.8	58.2%	52.0%
Tennessee Valley Authority	0.2	0.4	0.7	75.0%	68.1%
Commerce	15.2	17.4	23.6	35.6%	30.3%
Veterans Affairs	2.5	4.8	4.5	-6.3%	-10.0%
Agency for International Development	15.0	15.4	16.5	7.1%	2.9%
Smithsonian	5.0	4.0	4.0	0.0%	-3.9%
Interior	20.2	26.5	8.4	-68.3%	-69.6%
Education	1.8	6.5	1.7	-73.8%	-74.9%
Treasury	0.1	0.1	0.1	0.0%	-3.9%
Environmental Protection Agency	0.0	19.2	0.0	-100.0%	-100.0%
TOTAL R&D Facilities	$2,642.7	$3,063.1	$3,522.2	15.0%	10.5%
TOTAL R&D	$66,445.6	$68,073.0	$75,548.2	11.0%	6.6%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justifications. Constant FY 1982 dollars based on OMB fiscal year deflators for defense R&D and nondefense R&D.

Table II-2. R&D in the Department of Defense – FY 1992 Budget (budget authority in millions)

	FY 1990 Actual[1,2]	FY 1991 Estimate[2]	FY 1992 Budget	Percent Change FY 1991-92
Research, Development Test and Evaluation				
Research	$936.1	$1,169.0	$1,009.8	-13.6%
Exploratory Development	2,408.4	2,723.7	2,860.5	5.0%
Technology Base	$3,344.6	$3,892.7	$3,870.3	-0.6%
Advanced Technology Development	$5,833.3	$5,258.6	$7,225.0	37.4%
Strategic Programs	5,193.1	4,260.7	5,158.9	21.1%
Tactical Programs	13,245.8	13,494.6	14,232.6	5.5%
Intelligence and Communications Programs	4,790.6	4,474.2	5,183.8	15.9%
Defense-wide Mission Support	4,233.5	4,059.2	4,247.7	4.6%
TOTAL, RDT&E	$36,640.9	$35,440.0	$39,918.3	12.6%
Other Appropriations[3]	1,228.2	1,087.3	1,094.0	0.6%
TOTAL, DOD R&D	$37,869.1	$36,527.3	$41,012.3	12.3%
TOTAL, Conduct of R&D	$37,261.0	$36,066.0	$40,474.7	12.2%
TOTAL, R&D Facilities	$608.1	$461.3	$537.6	16.5%

Source: Department of Defense "RDT&E Programs (R-1)," OMB data for R&D analysis for FY 1992, and *Budget of the United States Government, Fiscal Year 1992.*

[1] Amounts for FY 1990 based on "budget plan," which does not equal budget authority.

[2] The amounts shown exceed the estimates in the R-1 by $9.0 million in FY 1990 and $881.1 million in FY 1991 (of which $43.6 million is basic research). The R-1 deducted these amounts pending submission of a rescission package.

[3] R&D support in military personnel, military construction, and other DOD appropriations.

Table II-3. DOD R&D by Military Department and Agencies (budget authority in millions)[1]

	FY 1990 Actual[2]	FY 1991 Estimate[2]	FY 1992 Budget	Percent Change FY 1991-92
Research, Development, Test and Evaluation				
Army	$5,300.0	$5,435.6	$6,236.4	14.7%
Navy	9,520.3	8,937.5	8,194.3	-8.3%
Air Force	13,584.8	11,794.0	15,154.6	28.5%
Defense Agencies	8,044.9	9,022.1	10,032.5	11.2%
Defense Mapping Agency[3]	265.5	232.0	233.7	0.7%
Strategic Defense Initiative Organization[3]	3,571.2	2,862.5	5,150.6	79.9%
Office, Secretary of Defense[3]	1,019.4	2,196.5	968.4	-55.9%
Defense Advanced Research Projects Agency[3]	1,216.6	1,461.1	1,166.5	-20.2%
Defense Nuclear Agency[3]	354.3	436.9	524.4	20.0%
Defense Support Project Office[3]	83.0	56.8	275.7	385.2%
Joint Chiefs of Staff[3]	0.0	84.1	62.3	-26.0%
Defense Communications Agency[3]	222.6	165.7	131.8	-20.5%
Defense Logistics Agency[3]	53.7	48.4	14.2	-70.7%
Uniformed Services University of the Health Sciences[3]	2.2	2.5	2.2	-10.5%
Special Operations Command[3]	0.0	191.1	276.1	44.5%
Undistributed[3]	0.0	113.0	—	—
All Other[3,4]	1,256.5	1,171.4	1,226.8	4.7%
Director of Test & Evaluation, Defense	178.2	237.3	286.3	20.6%
Director of Operational Test & Evaluation	12.7	13.6	14.2	4.8%
TOTAL, RDT&E	$36,640.9	$35,440.0	$39,918.3	12.6%

Table II-3. (continued)

	FY 1990 Actual[2]	FY 1991 Estimate[2]	FY 1992 Budget	Percent Change FY 1991-92
Other Appropriations[5]	1,228.2	1,087.3	1,094.0	0.6%
TOTAL, DOD R&D	$37,869.1	$36,527.3	$41,012.3	12.3%

Source: Department of Defense "RDT&E Programs (R-1)," OMB data for R&D analysis, and *Budget of the United States Government, Fiscal Year 1992.*

[1] Includes conduct of R&D and R&D facilities.

[2] The amounts shown exceed the estimates in the R-1 by $9.0 million in FY 1990 and $881.1 million in FY 1991. The R-1 deducted these amounts pending submission of a rescission package.

[3] Estimates for individual agencies may understate full funding in FY 1991 because the R-1 assumed a rescission totalling $113 million for Defense Agencies.

[4] Includes Defense Intelligence Agency, National Security Agency, and Joint Tactical C3 Agency.

[5] R&D support in military personnel, military construction, and other DOD appropriations.

Table II-4. Department of Defense R&D by Character of Work, FY 1992 Budget (budget authority in millions)

	FY 1990 Actual[1,2]	FY 1991 Estimate[2]	FY 1992 Budget	Percent Change FY 1991-92
Current Dollars				
Basic Research	$936.1	$1169.0	$1,009.8	-13.6%
Applied Research	2,408.4	2,723.7	2,860.5	5.0%
TOTAL, Research	$3,344.6	$3,892.7	$3,870.3	-0.6%
Development[3]	33,916.4	32,173.3	36,604.4	13.8%
TOTAL, Conduct of R&D	$37,261.0	$36,066.0	$40,474.7	12.2%
R&D Facilities	608.1	461.3	537.6	16.5%
TOTAL, R&D	$37,869.1	$36,527.3	$41,012.3	12.3%
Constant FY 1982 Dollars				
Basic Research	$713.6	$853.6	$708.3	-17.0%
Applied Research	1,836.0	1,988.8	2,006.5	0.9%
TOTAL, Research	$2,549.6	$2,842.4	$2,714.9	-4.5%
Development	25,854.9	23,492.8	25,676.5	9.3%
TOTAL, Conduct of R&D	$28,404.5	$26,335.2	$28,391.3	7.8%
R&D Facilities	463.6	336.8	377.1	12.0%
TOTAL, R&D	$28,868.0	$26,672.0	$28,768.4	7.9%

Source: Department of Defense "RDT&E Programs (R-1), OMB's data for R&D analysis, and *Budget of the United States Government, Fiscal Year 1992.* Constant dollars based on OMB fiscal year deflators for defense R&D.

[1] Amounts for FY 1990 based on "budget plan," which does not equal budget authority.

[2] The amounts shown exceed the estimates in the R-1 by $9.0 million in FY 1990 and $881.1 million in FY 1991 (of which $43.6 million is basic research). The R-1 deducted these amounts pending submission of a rescission package.

[3] Includes expenses of test and evaluation.

Table II-5. Department of Defense Funding for Basic Research (budget authority in millions)

	FY 1990 Actual[1,2]	FY 1991 Estimate[2]	FY 1992 Budget	Percent Change FY 1991-92
Army				
Defense Research Sciences	$171.1	$173.3	$179.4	3.5%
In-House Independent Research	8.8	8.8	14.8	67.7%
Electromechanics & Hypervelocity Physics	0.0	0.0	3.0	–
TOTAL, Army	$179.9	$182.2	$197.1	8.2%
Navy				
Defense Research Sciences	$338.6	$369.3	$395.8	7.2%
In-House Independent Research	24.3	24.1	25.9	7.2%
TOTAL, Navy	$363.0	$393.4	$421.6	7.2%
Air Force				
Defense Research Sciences	$186.1	$196.2	$203.2	3.6%
In-House Independent Research	7.5	7.2	10.0	37.6%
TOTAL, Air Force	$193.6	$203.4	$213.2	4.8%
Defense Agencies				
Undistributed[3]	–	$43.6	–	–
Defense Research Sciences[3]	$84.8	88.3	$88.3	0.0%
In-House Independent Research[3]	2.2	2.5	2.2	-10.5%
University Research Initiative[3]	94.8	230.7	87.4	-62.1%
HF Active Auroral[3]	9.9	0.0	0.0	–
Research Projects[3]	8.0	19.9	0.0	-100.0%
Critical Technology Center[3]	0.0	5.0	0.0	- 100.0%
TOTAL, Defense Agencies	$199.7	$390.0	$177.9	-54.4%

Table II-5. (continued)

	FY 1990 Actual[1,2]	FY 1991 Estimate[2]	FY 1992 Budget	Percent Change FY 1991-92
TOTAL DOD				
Defense Research Sciences[3]	$780.6	$827.1	$866.6	4.8%
In-House Independent Research[3]	42.9	42.7	52.9	23.8%
University Research Initiative[3]	94.8	230.7	87.4	-62.1%
HF Active Auroral[3]	9.9	0.0	0.0	--
Research Projects[3]	8.0	19.9	0.0	-100.0%
Critical Technology Center[3]	0.0	5.0	0.0	-100.0%
Electromechanics & Hypervelocity Physics[3]	0.0	0.0	3.0	–
Undistributed[3]	–	43.6	–	–
TOTAL, DOD Basic Research	$936.1	$1,169.0	$1,009.8	-13.6%

Source: Department of Defense "RDT&E Programs (R-1)," OMB's data for R&D analysis, and *Budget of the United States Government, Fiscal Year 1992.*

[1] Amounts for FY 1990 based on "budget plan," which does not equal budget authority.

[2] The amounts shown exceed the estimates in the R-1 by $9.0 million in FY 1990 and $88.1 million in FY 1991 (of which $43.6 million is basic research) because the R-1 assumed a rescission totalling $113 million for Defense Agencies.

[3] Estimates for individual agencies may understate full funding in FY 1991 because the R-1 assumed a rescission totalling $113 million for Defense Agencies.

Table II-6. Trends in Department of Defense R&D, FY 1965–1992 (in millions)

	Basic Research		Total DOD R&D	
Fiscal Years	Current $	Constant FY 1982 $	Current $	Constant FY 1982 $
1965	$347	$1,345	$6,865	$26,609
1970	323	944	7,491	21,891
1975	305	570	9,167	17,122
1980	552	676	14,150	17,336
1981	615	668	16,772	18,211
1982	697	697	20,866	20,866
1983	787	754	23,233	22,264
1984	843	784	26,940	25,056
1985	851	767	31,632	28,500
1986	954	840	35,000	30,807
1987	894	770	37,136	31,983
1988	897	742	38,126	31,569
1989	951	753	38,578	30,564
1990[1]	936	714	37,869	28,868
1991 Estimate[1]	1,169	854	36,527	26,672
1992 Budget	1,010	708	41,012	28,768

Source: National Science Foundation, *Federal Funds for Research and Development,* historical reports, and OMB's data for R&D analysis for FY 1992. Constant FY 1982 dollar conversions based on OMB fiscal year deflators for defense R&D.

[1] The amounts shown exceed the estimates in the R-1 by $9.0 million in FY 1990 and $881.1 million in FY 1991 (of which $43.6 million is in basic research). The R-1 deducted these amounts pending submission of a rescission package.

Table II-7. R&D in the National Science Foundation (budget authority in millions)[1]

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Mathematical and Physical Sciences (MPS)				
Mathematical Sciences	$69.3	$72.0	$79.5	10.4%
Astronomical Sciences	91.5	97.3	107.4	10.4%
Physics	123.8	129.0	142.0	10.1%
Chemistry	97.9	102.1	112.0	9.7%
Materials Research	117.0	122.6	136.6	11.4%
Science and Technology Centers	14.6	18.7	21.0	12.3%
Major Research Equipment	4.4	16.5	51.5	212.1%
TOTAL, MPS	$518.5	$558.2	$650.0	16.4%
Engineering				
Biological and Critical Systems	$35.6	$36.1	$41.6	15.2%
Chemical and Thermal Systems	30.8	33.0	38.3	16.1%
Electical and Communications	29.8	31.8	37.1	16.7%
Mechanical and Structural Systems	21.6	23.5	26.4	12.3%
Design and Manufacuring Systems	19.1	20.6	23.6	14.6%
Engineering Centers	46.4	50.7	55.2	8.9%
Engineering Infrastructure Development	16.8	20.1	25.6	27.4%
TOTAL, Engineering	$200.1	$215.8	$247.8	14.8%

Table II-7. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Biological, Behavioral and Social Sciences (BBS)				
Molecular Biosciences	$48.2	$51.3	$57.5	12.1%
Cellular Biosciences	57.7	61.0	67.9	11.3%
Biotic Systems and Resources	66.5	70.7	78.3	10.7%
Behavioral and Neural Sciences	45.8	47.9	51.6	7.7%
Social and Economic Sciences	32.3	35.0	41.3	18.0%
Instrumentation and Resources	38.3	40.2	48.5	20.6%
Science and Technology Centers	4.9	9.4	10.5	11.7%
TOTAL, BBS	$293.7	$315.5	$355.6	12.7%
Geosciences				
Atmospheric Sciences	$104.1	$114.5	$132.8	16.0%
Earth Sciences	60.1	68.3	74.7	9.4%
Ocean Sciences	147.4	164.8	188.5	14.4%
Arctic Research Program	12.5	15.0	17.7	18.0%
Science and Technology Centers	1.0	5.1	5.9	15.7%
TOTAL, Geosciences	$325.1	$367.7	$419.6	14.1%
Computer and Information Science and Engineering (CISE)				
Computer and Computation Research	$22.0	$24.2	$30.8	27.3%
Information, Robotics and Intelligent Systems	20.0	22.8	28.6	25.4%
Microelectronic Information Processing Systems	16.6	18.5	23.5	27.0%
Advanced Scientific Computing	62.8	62.1	70.4	13.4%
Networking and Communications Research and Infrastructure	22.3	29.8	42.2	41.6%
Cross-Disciplinary Activities	19.6	20.0	24.5	22.5%
Science and Technology Centers	6.6	8.8	9.4	7.5%
TOTAL, CISE	$169.9	$186.2	$229.4	23.3%

Table II-7. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Scientific, Technological, and International Affairs (STIA)				
Science Resources Studies	$5.3	$5.9	$6.8	15.3%
Policy Research and Analysis	1.1	0.9	0.9	0.0%
Experimental Program to Stimulate Competitive Research (EPSCOR)	9.8	11.0	15.0	36.4%
Industrial Science and Technological Innovation	20.0	21.6	25.4	17.6%
International Cooperative Scientific Activities	11.6	11.7	13.0	11.1%
TOTAL, STIA	$47.8	$51.1	$61.0	19.6%
TOTAL, Research and Related Activities	$1,554.9	$1,694.2	$1,963.5	15.9%
Education and Human Resources (EHR)				
Teacher Preparation and Enhancement	$81.0	$118.6	$139.0	17.2%
Materials Development and Informal Science	48.2	66.0	82.0	24.2%
Undergraduate Science, Engineering, and Mathematics Education	22.7	41.0	47.0	14.6%
Research Career Development	36.8	48.0	61.0	27.1%
Studies, Evaluation, and Dissemination	4.3	9.0	11.0	22.2%
Human Resources Development	27.6	39.9	50.0	25.5%
TOTAL, Education and Human Resources	$220.6	$322.5	$390.0	21.0%

Table II-7. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Academic Research Instrumentation	$0.0	$0.0	$50.0	–
Research Facilities Modernization	0.4	20.5	0.0	-100.0%
U.S. Antarctica Program	151.5	175.0	193.0	10.3%
Salaries and Expenses[2]	96.4	101.0	122.0	20.8%
Inspector General	2.6	3.0	3.5	16.7%
TOTAL, NSF Budget	$2,026.0	$2,316.0	$2,722.0	17.5%
Deduct Science Education non-R&D and other non-R&D	-297.2	-395.8	-480.1	21.3%
TOTAL, NSF R&D	$1,728.8	$1,920.2	$2,241.9	16.7%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

[1] Funding for facilities included in program totals.

[2] Formerly "Program Management."

Table II-8. R&D in the Department of Health and Human Services (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Conduct of R&D				
Health				
National Institutes of Health	$7,138.0	$7,713.8	$8,251.8	7.0%
Alcohol, Drug Abuse and Mental Health Administration	891.8	1,019.6	1,104.8	8.4%
Centers for Disease Control	95.6	109.6	113.3	3.4%
Food and Drug Administration	99.0	110.0	125.3	13.9%
Assistant Secretary for Health[1]	6.9	10.1	3.9	-61.4%
Health Care Financing Administration	12.9	12.2	0.0	-100.0%
Health Resources and Services	11.1	11.5	11.6	0.9%
Indian Health Services	0.7	0.7	0.7	0.0%
Health Care Policy and Research	49.7	95.8	34.3	-64.2%
TOTAL, Health	$8,305.7	$9,083.3	$9,645.7	6.2%
Human Services				
Office of Human Development Services	$93.8	$146.4	$151.4	3.4%
Social Security Administration	17.8	20.3	23.2	14.3%
Office of the Secretary	5.0	8.9	5.0	-43.8%
Family Support Administration	10.2	10.7	6.5	-39.3%
TOTAL, Human Services	$126.8	$186.3	$186.1	-0.1%
TOTAL, Conduct of R&D	$8,432.5	$9,269.6	$9,831.8	6.1%

Table II-8. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
R&D Facilities				
National Institutes of Health	$77.3	$175.5	$121.1	-31.0%
Alcohol, Drug Abuse and Mental Health Administration	0.1	7.8	7.8	0.0%
Food and Drug Administration	23.0	2.5	1.0	-60.0%
TOTAL, R&D Facilities	$100.4	$185.8	$129.9	-30.1%
TOTAL, HHS R&D	$8,532.9	$9,455.4	$9,961.7	5.4%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justifications.

[1] Includes funding for Public Health Service Management.

Table II-9. R&D in the National Institutes of Health by Institute (budget authority in millions)[1]

Institute	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Cancer	$1,592.5	$1,669.7	$1,770.6	6.0%
Heart, Lung and Blood	1,025.6	1,080.3	1,162.7	7.6%
Dental Research	129.6	142.9	154.8	8.3%
Diabetes, Digestive, and Kidney Diseases	556.3	590.8	633.9	7.3%
Neurological Disorders and Stroke	476.3	528.4	569.8	7.8%
Allergy and Infectious Diseases	813.8	887.1	955.6	7.7%
General Medical Sciences	627.8	668.0	738.3	10.5%
Child Health & Human Development	426.7	462.6	503.1	8.8%
Eye	228.9	245.9	264.8	7.7%
Environmental Health Sciences	218.2	230.1	243.5	5.8%
Aging	229.4	314.0	338.7	7.9%
Arthritis & Musculoskeletal & Skin Diseases	161.9	186.4	197.9	6.2%
Deafness and Communications Disorders	114.2	131.0	142.3	8.6%
Research Resources	334.6	332.6	303.2	-8.8%
Nursing Research	29.3	35.3	39.2	11.0%
Human Genome	56.6	83.3	105.2	26.3%
Fogarty International Center	15.7	17.5	19.9	13.7%
National Library of Medicine	85.7	91.4	100.6	10.1%
Office of Director	89.9	97.7	95.2	-2.6%
Adjustments	-75.0	-81.2	-87.5	7.8%
TOTAL, Conduct of R&D	$7,138.0	$7,713.8	$8,251.8	7.0%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

[1] Excludes training, construction, and buildings and facilities.

Table II-10. R&D in the National Institutes of Health by Funding Mechanism (budget authority in millions)[1]

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Research Grants				
Research Projects	$4,179.6	$4,497.6	$4,892.8	8.8%
Noncompeting	(3,200.8)	(3,296.9)	(3,617.6)	9.7%
Administrative Supplementals	(29.3)	(20.6)	(21.6)	4.9%
Competing	(949.6)	(1,180.1)	(1,253.5)	6.2%
Research Centers	632.6	713.5	746.3	4.6%
Other Research Grants	378.1	298.3	354.0	18.7%
R&D Contracts	568.1	615.0	645.8	5.0%
Intramural Research	860.0	924.9	987.9	6.8%
Research Management and Support	343.4	370.7	426.8	15.1%
Cancer Control	75.4	85.7	89.8	4.8%
Other	100.8	208.1	108.4	-47.9%
TOTAL, Conduct of R&D	$7,138.0	$7,713.8	$8,251.8	7.0%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

[1] Excludes training, construction, and buildings and facilities.

Table II-11. Research in the Alcohol, Drug Abuse, and Mental Health Administration (budget authority in millions)[1]

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
General Mental Health	$423.9	$494.9	$534.1	7.9%
Drug Abuse	247.8	290.6	320.7	10.4%
Alcoholism	142.3	151.2	163.1	7.9%
Undistributed R&D[2]	77.8	82.9	86.9	4.8%
Total, ADAMHA R&D	$891.8	$1,019.6	$1,104.6	8.4%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

[1] Excludes training and buildings and facilities.

[2] At the time this report went to press, ADAMHA had not allocated these amounts among the institutes. These amounts include funds for demonstrations and the Office of the Administrator.

Table II-12. R&D in the Department of Energy (budget authority in millions; includes plant and capital equipment)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
DOE Appropriations Containing R&D				
1. Energy Supply R&D	$1,669.9	$1,901.7	$2,011.2	5.8%
2. Fossil Energy R&D	344.5	387.0	181.7	-53.0%
3. Energy Conservation	180.1	219.1	278.7	27.2%
4. General Science and Research	1,078.0	1,137.7	1,531.5	34.6%
5. Atomic Energy Defense Activities	2,921.9	2,988.2	3,152.4	5.5%
6. Uranium Enrichment	131.4	154.5	213.6	38.3%
7. Clean Coal Technology	524.8	366.0	290.0	-20.8%
8. Environmental Restoration	187.3	206.0	330.3	60.3%
Total, DOE R&D	$7,037.9	$7,360.2	$7,989.4	8.5%
1. Energy Supply R&D				
Solar and Renewable Energy[1]				
Utility Technologies	$100.9	$144.4	$150.6	4.3%
Building Technologies	3.9	2.0	1.2	-39.2%
Industrial Technologies	5.8	10.6	9.8	-6.7%
Transportation Technologies	16.1	26.2	29.6	13.3%
Technical and Financial Assistance	6.6	8.1	4.0	-50.5%
Total, Solar and Renewable Energy	$133.2	$191.2	$195.3	2.1%
Nuclear Energy				
Light Water Reactors	$24.1	$38.5	$62.5	62.3%
Advanced Reactor R&D	58.0	57.0	49.5	-13.2%
Advanced Radio Isotope Power Systems	48.9	75.5	56.0	-25.8%
Space/Reactor Power Systems	31.3	33.5	56.0	67.2%
Facilities	168.8	92.5	127.8	38.2%
Space Exploration Initiative	0.0	0.0	30.0	–
Total, Nuclear Energy	$331.1	$297.0	$381.8	28.6%

Table II-12. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Environment, Safety, and Health	$1.1	$1.1	$37.9	3345.5%
Biological and Environmental Research	$300.6	$388.3	$306.5	-21.1%
Magnetic Fusion	$311.8	$268.1	$329.6	22.9%
Basic Energy Sciences				
Materials Sciences	196.2	274.9	257.1	-6.5%
Chemical Sciences	138.5	157.6	158.3	0.4%
Applied Mathematical Sciences	43.2	52.7	75.5	43.3%
Engineering and Geosciences	32.8	34.3	35.8	4.4%
Advanced Energy Projects	14.4	24.9	10.8	-56.6%
Energy Biosciences	20.4	22.1	24.7	11.8%
Capital Equipment and Construction	113.3	139.2	145.0	4.2%
TOTAL, Basic Energy Sciences	$558.8	$705.7	$707.2	0.2%
Energy Research Analysis	3.8	3.7	4.0	7.6%
University and Science Education[2]	29.5	46.6	48.9	4.9%
TOTAL, Energy Supply R&D	$[illegible]669.9	$1,901.7	$2,011.2	5.8%
2. Fossil Energy R&D				
Coal	$276.1	$289.1	$115.0	-60.2%
Petroleum	39.0	59.0	52.2	-11.5%
Gas	14.4	15.9	8.0	-49.7%
Cooperative R&D	4.6	11.9	5.7	-52.1%
Facilities	12.0	15.8	0.8	-94.9%
Less Use of Prior Year Balances	-1.6	-4.7	0.0	—
TOTAL, Fossil Energy R&D	$344.5	$387.0	$181.7	-53.0%

Table II-12. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
3. Energy Conservation[3]				
Building Technologies	$26.5	$39.4	$50.3	27.5%
Industrial Technologies	73.0	80.9	99.0	22.4%
Transportation Technologies	65.5	81.0	107.7	33.0%
Technical and Financial Assistance	9.6	9.6	11.3	17.0%
Utility Technologies	3.4	4.2	6.8	0.0%
Policy and Management	2.1	3.9	3.6	-8.8%
TOTAL, Energy Conservation R&D	$180.1	$219.1	$278.7	27.2%
4. General Science and Research				
High Energy Physics	$576.3	$588.6	$666.4	13.2%
Nuclear Physics	287.2	313.3	342.4	9.3%
Superconducting Super Collider	214.5	235.8	522.7	121.7%
TOTAL, General Science and Research	$1,078.0	$1,137.7	$1,531.5	34.6%
5. Atomic Energy Defense Activities				
Naval Reactors Development	$628.9	$638.0	$662.2	3.8%
Weapons R&D and Testing	1,780.0	1,737.1	1,764.0	1.5%
Verification and Control Technology	53.8	66.6	83.4	25.2%
Nuclear Safeguards and Security	34.4	34.7	35.7	2.9%
Materials Production	137.6	156.1	159.0	1.9%
New Production Reactor	281.6	349.9	441.2	26.1%
Office of Intelligence	5.6	5.8	6.9	19.0%
TOTAL, Atomic Energy Defense Activities	$2,921.9	$2,988.2	$3,152.4	5.5%

Table II-12. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
6. Uranium Enrichment	$131.4	$154.5	$213.6	38.3%
7. Clean Coal Technology	$524.8	$366.0	$290.0	-20.8%
8. Environmental Restoration	$187.3	$206.0	$330.3	60.3%
TOTAL, DOE R&D	$7,037.9	$7,360.2	$7,989.4	8.5%

Source: Author's estimates based on OMB's data for R&D analysis for 1992 and agency budget justification.

[1] Former programs including Solar, Geothermal, Hydropower, and Electric Energy and Energy Storage Systems were reorganized under these categories in FY 1992.

2Formerly University Research Support and University Research Instrumentation.

[3] Former programs of Energy Conservation were reorganized under these categories in FY 1992.

Table II-13. Department of Energy Funding to Multiprogram National Laboratories by Program Type (obligations in millions)

	Energy Supply R&D	Atomic Energy Defense Activities	General Science & Research	Fossil Energy R&D	Energy Conser-vation	Other[1]	Total
Ames Laboratory	$20.0	$0.4	$1.2	$0.1	$0.3	$0.0	$22.0
(Change from FY 91)	(-5.5)	(-83.5)	(-11.2)	(96.9)	(0.0)	(-100.0)	(2.2)
Argonne National Laboratory	228.0	10.0	24.4	1.6	7.3	18.4	289.7
(Change from FY 91)	(7.2)	(-46.7)	(9.9)	(-68.7)	(5.4)	(15.7)	(1.1)
Brookhaven National Laboratory	125.5	3.8	164.0	0.4	1.9	11.6	307.2
(Change from FY 91)	(1.7)	(-41.2)	(33.3)	(-52.6)	(39.7)	(70.4)	(17.8)
Idaho Nat'l. Engineering Laboratory	3.8	230.7	0.0	0.0	2.9	0.1	237.5
(Change from FY 91)	(17.1)	(7.9)	–	–	(-48.7)	–	(18.3)
Lawrence Berkeley Laboratory	114.6	0.1	61.4	0.8	10.1	13.9	201.0
(Change from FY 91)	(-1.3)	(-0.3)	(2.8)	(-55.8	(6.4)	(32.4)	(8.4)
Lawrence Livermore Laboratory	80.0	525.7	5.7	0.5	1.8	188.1	801.8
(Change from FY 91)	(2.6)	(-4.0)	(-26.7)	(-89.2)	(218.2)	(135.7)	(41.3)
Los Alamos Scientific Laboratory	77.7	630.5	57.5	0.5	2.7	15.0	783.9
(Change from FY 91)	(-6.6)	(10.2)	(2.1)	(7.5)	(-43.6)	(1.4)	(41.6)
Oak Ridge National Laboratory	233.3	125.5	14.2	5.2	33.9	22.2	434.3
(Change from FY 91)	(7.7)	(27.3)	(5.2)	(44.6)	(13.7)	(42.3)	(39.3)
Pacific Northwest Laboratory	66.4	31.2	0.1	0.9	11.6	5.0	115.3
(Change from FY 91)	(11.3)	(10.7)	(-53.0)	(-38.8)	(11.9)	(32.4)	(2.5)
Sandia Laboratories	68.2	798.4	0.1	3.3	9.0	17.3	897.3
(Change from FY 91)	(-2.1)	(5.0)	–	(-54.6)	(81.1)	(13.7)	(12.0)
Savannah River Laboratory	0.6	56.7	0.0	0.0	0.0	0.0	57.3
(Change from FY 91)	(98.4)	(16.6)	–	–	–	(0.0)	(6.5)

Table II-13. (continued)

	Energy Supply R&D	Atomic Energy Defense Activities	General Science & Research	Fossil Energy R&D	Energy Conser-vation	Other[1]	Total
Westinghouse Hanford Company	$35.8	$34.2	$0.0	$0.1	$0.0	$0.0	$70.0
(Change from FY 91)	(164.8)	(-88.4)	–	(15.6)	–	(0.0)	(23.8)
TOTAL	$1,054.0	$2,447.2	$328.6	$13.4	$81.5	$155.9	$4,218.0
(Change from FY 91)	(57.7)	(-97.6)	(-39.6)	(-15.6)	(6.7)	(54.0)	(199.7)

Source: Department of Energy, Office of Energy Research. (See Table II-12 for breakdown of program types.)

[1] "Other" includes: Nuclear Waste Fund, Departmental Administration, Clean Coal Technology, Economic Regulation, the Strategic Petroleum Reserve, Isotope Production and Distribution Fund, and Uranium Enrichment.

Table II-14. R&D in the National Aeronautics and Space Administration (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Research and Development Appropriation				
Space Station	$1,749.6	$1,900.0	$2,028.9	6.8%
Space Transportation Capability Development	558.1	602.5	879.8	46.0%
Space Science and Applications	1,998.3	2,429.6	2,934.6	20.8%
Physics and Astronomy	859.4	975.1	1,140.6	17.0%
Life Sciences	106.1	138.0	183.9	33.3%
Planetary Exploration	390.8	457.1	627.3	37.2%
Earth Science and Applications	434.2	667.9	775.6	16.1%
Materials Processing	101.9	102.3	125.8	23.0%
Communications	77.7	52.5	39.4	-25.0%
Information Systems	28.2	36.7	42.0	14.4%
Commercial Programs	56.5	86.0	150.0	74.4%
Technology Utilization	23.7	24.4	32.0	31.1%
Commercial Use of Space	32.8	61.6	118.0	91.6%
Aeronautics Research and Technology	442.6	512.0	591.2	15.5%
Transatmospheric Research and Technology	59.0	95.0	72.0	-24.2%
Space Research and Technology	284.0	290.4	421.8	45.2%
Safety, Reliability, and Quality Assurance	22.6	33.0	33.6	1.8%
Space Tracking and Data Systems	19.3	20.0	22.0	10.0%
Academic Programs	37.5	55.1	64.6	17.2%
BA Adjustment	-3.0	0	0	–
TOTAL, R&D Appropriation	$5,224.7	$6,023.6	$7,198.5	19.5%
TOTAL, R&D in Other Appropriations[1]	$1,886.9	$2,104.3	$2,288.2	8.7%
TOTAL, NASA R&D	$7,111.6	$8,127.9	$9,486.7	16.7%

Table II-14. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
TOTAL, NASA R&D	$7,111.6	$8,127.9	$9,486.7	16.7%
Conduct of R&D	(6,481.2)	(7,271.3)	(8,601.7)	18.3%
R&D Facilities	(630.4)	(856.6)	(885.0)	3.3%
TOTAL, NASA Operations^2	$5,110.0	$5,740.4	$6,234.6	8.6%
TOTAL, NASA Budget Authority	$12,221.6	$13,868.3	$15,721.3	13.4%
Detail of Research and Development Appropriation				
Space Station	$1,749.6	$1,900.0	$2,028.9	6.8%
Space Transportation: Capability Development				
Spacelab	$93.7	$129.3	$150.2	16.2%
Shuttle Upper Stages	79.7	82.2	108.5	32.0%
Engineering and Technology Base	181.6	208.5	235.2	12.8%
Payload Operations and Support Equipment	65.5	101.5	144.5	42.4%
Advanced Programs	34.7	35.2	53.8	52.8%
New Launch System	0.0	23.9	175.0	632.2%
Tethered Satellite System	27.3	21.9	12.6	-42.5%
Orbital Maneuvering Vehicle	75.7	0.0	0.0	—
TOTAL, Space Transportation: Capability Development	$558.1	$602.5	$879.8	46.0%
Physics and Astronomy				
Space Telescope Development	$81.8	$0.0	$0.0	—
Gamma Ray Observation Development	41.2	22.0	0.0	-100.0%
Advanced X-Ray Astrophysics Facility	44.0	101.2	211.0	108.5%
Global Geospace Science	57.6	96.6	65.3	-32.4%
Space Lab/Space Station Payload Development and Mission Management	75.1	88.8	88.0	-0.9%
Space Station Integrated Planning	5.0	3.0	0.0	-100.0%
Payload and Instrument Development	93.0	94.6	115.9	22.5%

Table II-14. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Explorer Development	$88.4	$99.8	$107.9	8.1%
Mission Operations and Data Analysis	215.7	313.3	388.4	24.0%
Research and Analysis	104.9	100.8	103.1	2.3%
Suborbital Program	52.7	55.0	61.0	10.9%
TOTAL, Physics and Astronomy	$859.4	$975.1	$1,140.6	17.0%
Planetary Exploration				
Galileo (Jupiter) Development	$17.1	$0.0	$0.0	—
Mars Observer	98.9	78.5	54.4	-30.7%
Ulysses International Solar Polar Mission	14.3	3.0	0.0	-100.0%
Comet Rendezvous/Asteroid Flyby	29.5	145.0	328.0	126.2%
Mars Balloon Relay Experiment	4.4	1.5	1.2	-19.8%
Mission Operations and Data Analysis	156.0	161.2	150.5	-6.6%
Research and Analysis	70.7	67.9	93.2	37.3%
TOTAL, Planetary Exploration	$390.8	$457.1	$627.3	37.2%
Life Sciences				
Human Flight and Systems Engineering	$40.7	$58.3	$58.6	0.5%
Space Biological Systems	21.1	22.8	31.1	36.4%
Lifesat	[1.6][3]	[2.0][3]	15.0	—
Search for Extraterrestrial Intelligence	4.0	12.1	14.5	19.8%
Research and Analysis	40.3	44.8	64.7	44.4%
TOTAL, Life Sciences	$106.1	$138.0	$183.9	33.3%

Table II-14. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Earth Science and Applications				
Payload Instrument Development	$76.1	$49.7	$48.6	-2.2%
Upper Atmosphere Research Satellite	55.2	64.0	18.2	-71.6%
Ocean Topography Experiment	84.8	76.0	51.9	-31.7%
Mission Operations and Data Analysis	23.8	39.4	56.3	42.9%
Earth Observing System (EOS)	[74.0]^3	155.0	253.4	63.5%
EOS Data Information System	0.0	36.0	82.6	129.4%
Earth Probes/Scatterometer	13.6	54.7	68.2	24.7%
Remotely Piloted Aircraft	0.0	0.0	5.0	–
Process Studies	106.2	107.5	114.3	6.3%
Modelling and Data Analysis	38.5	44.3	45.0	1.6%
Research Facilities	27.4	28.9	29.6	2.4%
Interdisciplinary Research	8.6	12.4	2.5	-79.8%
TOTAL, Earth Science and Applications	$434.2	$667.9	$775.6	16.1%
Other Space Applications				
Materials Processing in Space	$101.9	$102.3	$125.8	23.0%
Advanced Communications Technology Systems	60.0	34.0	11.2	-67.1%
Advanced Communications Research	12.3	11.4	15.3	34.7%
Other Communications	5.4	7.1	12.9	80.6%
Information Systems R&D	28.2	36.7	42.0	14.4%
TOTAL, Other Space Applications	$207.8	$191.5	$207.2	8.2%
Commercial Programs				
Technology Utilization	$23.7	$24.4	$32.0	31.1%
Commercial Use of Space	32.8	61.6	118.0	91.6%
TOTAL, Commercial Programs	$56.5	$86.0	$150.0	74.4%

Table II-14. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Aeronautics Technology				
Research & Technology Base	$321.8	$336.4	$375.6	11.7%
Systems Technology Programs	120.8	175.6	215.6	22.8%
TOTAL, Aeronautics Technology	$442.6	$512.0	$591.2	15.5%
Space Research and Technology				
Resource and Technology Base	$125.0	$125.7	$141.6	12.6%
In-space Experiments Technology Program	10.2	11.2	16.0	42.9%
Civilian Space Technology Initiative	121.4	119.0	114.3	-3.9%
Exploration Technology	27.5	27.5	52.0	89.1%
Space Automation and Telerobotics	0.0	0.0	82.9	–
Exploration Mission Studies	[15.0][3]	7.0	15.0	114.3%
TOTAL, Space Research and Technology	$284.0	$290.4	$421.8	45.2%
Transatmospheric R&T/Space Plane	$59.0	$95.0	$72.0	-24.2%
Safety, Reliability, and Quality Assurance	$22.6	$33.0	$33.6	1.8%
Space Tracking and Data Systems	$19.3	$20.0	$22.0	10.0%
Academic Programs	$37.5	$55.1	$64.6	17.2%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

[1] R&D funding in "Research and Program Management" and "Construction of Facilities" accounts.

[2] Includes Space Flight, Control and Data Communications funding and the non-R&D portion of the "Research and Program Management" account.

[3] Brackets denote funds included elsewhere in prior years for purposes of comparison.

Table II-15. R&D in the Department of Agriculture (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Conduct of R&D				
Agricultural Research Service	$548.4	$589.1	$623.4	5.8%
Cooperative State Research Service	324.7	376.7	373.1	-1.0%
Competitive Research Grants	42.5	73.0	125.0	71.2%
Agricultural Experiment Stations	155.1	162.3	168.3	3.7%
Cooperative Forestry Research	17.3	17.8	13.0	-27.2%
1890 Colleges and Tuskegee	25.0	26.3	27.3	3.7%
1890 Capacity Building Grants	3.3	4.0	5.4	35.0%
Special Research Grants	56.3	62.4	26.7	-57.2%
Animal Health and Disease Research	5.4	5.6	0.0	-100.0%
Administration	7.6	9.6	2.0	-79.2%
Aquaculture	3.7	3.8	0.0	-100.0%
Alternative Crops Research	0.3	1.2	0.9	-25.0%
International Trade Development	3.1	3.2	0.0	-100.0%
Agriculture Productivity	4.4	6.7	4.5	-32.8%
Critical Materials	0.7	0.8	0.0	-100.0%
Forest Service	150.9	167.6	163.2	-2.6%
Economics Research Service	50.7	54.4	62.5	14.9%
Agricultural Cooperative Service	3.4	3.4	3.5	2.9%
Agricultural Marketing Service	2.7	3.0	3.2	6.7%
Office of International Cooperation and Development	2.3	2.6	1.6	-38.5%
Human Nutrition Information Service	9.0	9.9	12.6	27.3%
National Agricultural Statistics Service	2.8	2.9	3.0	3.4%
Animal and Plant Inspection Service	13.0	13.8	14.6	5.8%
Federal Grain Inspection Service	0.3	0.7	0.7	0.0%
TOTAL, Conduct of R&D	$1,108.2	$1,224.1	$1,261.4	3.0%

Table II-15. (continued)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Facilities				
Agricultural Research Service	$55.5	$83.5	$93.3	11.7%
Cooperative Research Service	49.7	62.9	25.0	-60.3%
Forest Service	4.9	4.4	3.6	-18.2%
Animal and Plant Inspection Service	5.0	5.0	6.5	30.0%
TOTAL, Facilities	$115.1	$155.8	$128.4	-17.6%
TOTAL, USDA R&D	$1,223.2	$1,379.9	$1,389.8	0.7%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

Table II-16. R&D in the Environmental Protection Agency by Media (budget authority in millions)[1]

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Air Quality	$77.9	$86.6	$112.4	29.8%
Water Quality	26.9	27.7	28.9	4.3%
Drinking Water	20.9	20.7	22.2	7.3%
Hazardous Waste	43.9	39.2	43.6	11.3%
Pesticides	12.7	12.6	15.0	19.0%
Radiation	3.6	4.0	4.0	-0.5%
Multimedia	83.5	123.2	150.7	22.3%
Toxic Substances	27.2	25.5	26.3	3.1%
Energy	33.3	13.6	13.7	0.4%
Superfund	78.7	73.6	68.6	-6.8%
Leaking Underground Storage Tanks	0.7	0.8	0.8	0.0%
Management and Support	14.8	5.2	5.3	2.3%
Buildings and Facilities	0.0	19.2	0.0	-100.0%
TOTAL, EPA R&D	$424.2	$452.0	$491.3	8.7%

Source: Agency budget justification.

[1] Includes conduct of R&D and R&D facilities.

Table II-17. R&D in the Environmental Protection Agency by Program (budget authority in millions)[1]

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Environmental Engineering and Technology[2]	$100.5	$93.5	$86.7	-7.3%
Monitoring, Characterization, and Quality Assurance[3]	61.5	61.3	84.4	37.8%
Core Research	55.8	66.4	78.8	18.7%
Environmental Processes and Effects	44.1	43.9	52.7	20.0%
Health Effects	47.2	42.4	43.6	2.7%
Stratospheric Modification	14.8	20.0	25.5	27.6%
Acid Deposition	29.8	10.1	10.2	0.2%
Scientific Assessment	20.8	19.2	23.2	21.0%
Technical Information and Liaison	11.2	11.5	12.7	10.4%
Exploratory Research Program	7.7	10.6	9.3	-11.7%
Interdisciplinary Activities	3.0	4.9	3.0	-38.9%
Other Quality Assurance	1.7	2.6	3.2	19.9%
Great Lakes Study	2.0	2.2	4.6	111.4%
Integrated Hazardous Waste Research	2.4	3.6	0.4	-88.7%
Management Support[4]	15.6	40.5	49.5	22.3%
Capital Investment	6.0	0.0	3.6	–
Facilities	0.0	19.2	0.0	-100.0%
TOTAL, EPA R&D	$424.2	$452.0	$491.3	8.7%

Source: Agency budget justification.

[1] Includes conduct of R&D and R&D facilities.

[2] Includes oil spill R&D, which previously was treated as a separate category totaling $1.2 million in FY 1990 and $4 million in FY 1991.

[3] Includes air quality "characterization, transport and fate" research, which previously was a separate category totaling $11.5 million in FY 1990 and $14.6 million in FY 1991.

[4] Starting in FY 1991, part of intramural R&D has been included in the "multi-media" program.

Table II-18. R&D in the Department of the Interior (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Conduct of R&D				
Geological Survey	$308.4	$352.8	$339.0	-3.9%
Bureau of Mines	100.5	108.4	82.1	-24.3%
Fish and Wildlife Service	70.8	81.8	80.1	-2.1%
National Park Service	19.6	22.7	28.0	23.3%
Bureau of Reclamation	5.1	8.6	14.0	62.8%
Bureau of Land Management	3.0	5.3	10.7	101.9%
Office of Surface Mining Reclamation and Enforcement	1.0	1.3	1.0	-23.1%
Minerals Management Service	2.0	2.5	5.9	136.0%
Office of the Secretary	0.2	0.7	1.1	57.1%
TOTAL, Conduct of R&D	$510.6	$584.1	$561.9	-3.8%
R&D Facilities				
Geological Survey	1.3	1.8	1.8	0.0%
Bureau of Mines	0.5	0.6	0.6	0.0%
Fish and Wildlife Service	18.4	24.1	6.0	-75.1%
TOTAL, R&D Facilities	$20.2	$26.5	$8.4	-68.3%
TOTAL, Interior R&D	$530.8	$610.6	$570.3	-6.6%

Source: OMB's data for R&D analysis for FY 1992.

Table II-19. R&D in the Department of Transportation (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Conduct of R&D				
Federal Aviation Administration	$188.0	$228.3	$234.1	2.5%
Federal Highway Administration	82.5	103.4	102.6	-0.8%
National Highway Traffic Safety Administration	16.9	21.4	23.7	10.7%
Coast Guard	20.1	24.6	28.4	15.4%
Federal Railroad Administration	9.5	20.7	25.8	24.6%
Office of the Secretary	6.8	4.0	5.9	47.5%
Research and Special Programs Administration	2.4	2.3	3.0	30.4%
Urban Mass Transit Administration	1.6	1.6	9.4	487.5%
Maritime Administration	0.9	1.0	2.0	100.0%
TOTAL, Conduct of R&D	$328.6	$407.1	$434.9	6.8%
R&D Facilities				
Federal Aviation Administration	$24.7	$16.3	$27.9	71.2%
Federal Railroad Administration	0	1.5	0.5	-66.7%
Coast Guard	0.4	0.4	0.4	0.0%
Total, R&D Facilities	$25.1	$18.2	$28.8	58.2%
TOTAL, DOT R&D	$353.7	$425.3	$463.7	9.0%

Source: OMB's data for R&D analysis for FY 1992.

Table II-20. R&D in the Department of Commerce (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Conduct of R&D				
National Oceanic and Atmospheric Administration	$296.1	$340.0	$338.0	-0.6%
National Institute of Standards and Technology	125.5	161.9	184.2	13.8%
National Telecommunications and Information Administration	7.7	7.9	10.0	26.6%
Bureau of the Census	6.9	5.5	5.8	5.5%
Economic Development Administration	1.2	1.2	0.0	-100.0%
TOTAL, Conduct of R&D	$437.4	$516.5	$538.0	4.2%
R&D Facilities				
National Oceanic and Atmospheric Administration	$5.8	$3.8	$3.1	-18.4%
National Institute of Standards and Technology	9.4	13.6	20.5	50.7%
TOTAL, R&D Facilities	$15.2	$17.4	$23.6	35.6%
TOTAL, Commerce R&D	$452.6	$533.9	$561.6	5.2%

Source: OMB's data for R&D analysis for FY 1992 and agency budget justification.

Table II-21. R&D in the Department of Education (budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget	Percent Change FY 1991-92
Conduct of R&D				
Rehabilitation Services and Handicapped Research	$53.1	$53.5	$56.8	6.2%
Education Research and Statistics	28.4	51.2	69.3	35.4%
Handicapped Special Purpose Funds	33.4	34.3	34.3	0.0%
Vocational/Adult Education	16.3	20.6	24.4	18.4%
Bilingual Education	2.6	2.7	2.3	-14.8%
International Education and Foreign Language Studies	1.8	2.0	1.5	-25.0%
Science and Math Programs of National Significance	0.5	0.0	0.0	–
Fund for the Improvement of Postsecondary Education	0.4	0.4	0.4	0.0%
Program Administration	3.5	3.7	3.7	0.0%
All Other	21.5	24.8	25.0	0.8%
TOTAL, Conduct of R&D	$161.5	$193.2	$217.7	12.7%
R&D Facilities				
Academic Facilities Construction Grants	$0.0	$4.8	$0.0	-100.0%
Howard University	1.8	1.7	1.7	0.0%
TOTAL, Facilities	$1.8	$6.5	$1.7	-73.8%
TOTAL, Education R&D	$163.3	$199.7	$219.4	9.9%

Source: Agency budget justification.

Part III: Disciplinary Analyses

Introduction

The chapters that follow take a cross-cutting view of the FY 1992 figures for R&D to the preceding agency chapters -- summarizing the R&D prospects for some of the major scientific and engineering disciplines and research areas. In each case, the budgets of various agencies which provide support for these disciplinary areas are examined, and policy issues and funding trends are discussed in terms of their impacts on the disciplines. Tables in these chapters, on the whole, contain detail of agency R&D programs not shown in the tables that appear at the end of Part II.

Chapter 12

Physics in the FY 1992 Budget

American Institute of Physics

Richard M. Jones

One of the most important questions posed by the FY 1992 budget request is the Administration's support of both large scientific undertakings and "small science." Perhaps nowhere else in the budget is there greater contrast between big and small science than in physics research.

The Administration's proposed 120 percent increase in funding for the superconducting super collider is the most noticeable and controversial physics-related request in the new budget. Other sections of the budget contain increases for physics research, such as the proposed 23 percent increase for fusion research at the Department of Energy and the 10 percent increase for the National Science Foundation's physics subactivity. There is, however, concern in the physics community that even with these increases, physics-related research may lag.

The Administration is aware of the concern in the science community and Congress that funding for the superconducting super collider is coming at the expense of "small science." Prominent in the initial section of the budget is the statement: "Even though the budget proposes a substantial increase for the SSC, this funding will not come at the expense of other science programs. In particular, the budget proposes a 16 percent increase in basic research, principally for individual investigators, at the National Science Foundation." Support for physics research at the NSF would, it should be noted, increase by only 10.1 percent.

This chapter focuses on areas of the budget providing the clearest evidence of the Administration's support for physics. Reviews will be made of the budgets for the Department of Energy, the National Science Foundation, and the National Institute of Standards and Technology.

Department of Energy:

Much of the Department of Energy's (DOE) support for physics is found in this year's budget request in the section, "Fortifying Our Foundations." Programs include High Energy Physics, Nuclear Physics, the Superconducting Super Collider, Basic Energy Sciences, and, in a separate section, Fusion Energy. Proposed increases range from 9.3 percent to 120 percent.

The Superconducting Super Collider, High Energy Physics, and Nuclear Physics have a high profile in the Administration's 2,029-page budget request. As early as page 45 of Part II of this document, the Administration describes the rationale for its budget request in these areas.

High Energy Physics

The 13.2 percent increase sought by DOE for High Energy Physics is one of the largest percentage increases in the department's physics-related budget. Funding would increase by $77.18 million to $664.4 million in the new fiscal year.

High energy physics studies the fundamental constituents of matter and the fundamental forces in nature. Large particle accelerators, colliding beam devices and large particle detectors are critical for discoveries in this field.

DOE maintains a number of high energy physics facilities which will be used for, among other experiments, improved direct tests of the Standard Model. The budget states that the "operations of the forefront research capabilities of the Stanford Linear Collider and of the Tevatron accelerator/collider will be conducted at the maximum reasonable level."

DOE proposes that construction begin of the Main Injector at Fermilab in FY 1992. Work at this facility is expected to support SSC physics goals and its design.

The budget states that one of its "key factors" in this program is the effective participation of university scientists. The budget for high energy physics research would increase by 10 percent, while the construction budget would increase by 103 percent.

Superconducting Super Collider

The superconducting super collider (SSC) is one of the big winners in the proposed FY 1992 budget. The Administration requests a 120 percent increase for the SSC, with funding increasing by $290.2 million to $533.7 million. DOE's posture statement notes that "the SSC is a critical part of the Administration's initiative to strengthen the position of the Nation as a world leader in science and technology."

Released with the budget request was DOE's long-awaited "Report on the Superconducting Super Collider Cost and Schedule Base." This report projected the SSC's cost at $8,249 million, with completion scheduled by the end of FY 1999.

This 83-page report reconciled four SSC cost estimates varying in the size of the contingency fund, and in one estimate, the detectors. DOE settled on two large, general-purpose detectors, and a 20 percent contingency fund. It delayed completion by one year because of concerns about congressional reactions to a budget request larger than what it is proposing for FY 1992.

Of the $533.7 million requested, $103.6 million would be for R&D on superconducting magnets, other accelerator systems, detector subsystems, and DOE program direction costs. DOE requests $56.3 million for capital equipment, with an additional $373.8 million for construction. Included under this latter category is "detailed design of technical systems and conventional facilities, the magnet industrialization program, fabrication of injector and collider technical systems and components," and construction of conventional facilities.

Although the $534 million sought in this year's budget represents a significant increase, DOE is projecting even larger annual requests of $710 million in FY 1994 through FY 1996.

Nuclear Physics

The Department of Energy requested an increase of 9.3 percent for Nuclear Physics in FY 1992. Funding would increase by $29.1 million to $342.4 million.

Nuclear physics research concentrates on understanding the structure of the nuclei and the forces holding them together.

DOE places special emphasis on the effective use of upgraded accelerators at the University of Washington and Yale University, and Tandem/AGS high energy heavy ion beams at Brookhaven National Laboratory in its FY 1992 request.

The largest construction project in DOE's nuclear physics program in FY 1992 is the Relativistic Heavy Ion Collider at Brookhaven National Laboratory. Construction funding for the CEBAF (Continuous Electron Beam Accelerator Facility) program will have peaked, with most work concentrating on accelerator component assembly and installation.

Under this program, the capital equipment budget increases by 16 percent, with the construction budget increasing by 12 percent. Operating expenses would increase by 7 percent, with funding under this category increasing by only 4 percent in some areas.

Basic Energy Sciences

An initial comparison of the FY 1991 and FY 1992 Basic Energy Sciences budgets shows an increase of 0.4 percent. The "fine print" accompanying the larger budget request document explains that DOE is shifting some FY 1991 programs into other areas. Taking this into account, DOE projects a 10 percent increase in basic energy sciences. The $66.9 million increase would result in a total budget of $714.7 million.

DOE's posture statement explains that the "BES program supports research which provides the foundation for new technologies and improvements to existing technologies which are crucial to achieving the goals of the National Energy Strategy."

A number of physics-related programs are supported by DOE's basic energy sciences research. In particular is the materials sciences program, increasing by 13 percent in the new budget. Of this $29 million increase, materials sciences research would increase by 4 percent and facilities operations by 29 percent. The department would "zero-out" congressional directed projects.

Under this budget, preconstruction R&D funding would increase for two new synchrotron projects.

Fusion Energy

Funding for Fusion Energy is found in the budget under "Securing Future Energy Supplies." DOE proposes a budget increase of 23.2 percent, or $63.5 million, for a total of $337.1 million in FY 1992.

DOE's budget document reviews the earlier work of the Fusion Policy Advisory Committee which concluded that the United States should initiate a "goal-oriented fusion energy program." It recommends participation in four different fusion projects. DOE set a primary long-term goal of an operating fusion demonstration plant by 2025, and an operating commercial power plant by 2040.

DOE supports "two separate and distinct approaches" to the development of fusion energy: magnetic fusion energy and inertial fusion energy. Doing so, they believe, will reduce technological risk. Magnetic fusion energy research would receive $328.9 million, and inertial fusion $8.2 million.

It should be noted that DOE's major support for inertial fusion research is in its Weapons R&D program. Funding for this inertial fusion activity would increase from $175 million to a proposed budget of $182.5 million.

A portion of DOE's magnetic fusion support will be for the four-country International Thermonuclear Experimental Reactor, a six-year collaboration which DOE describes as a "model for international cooperation in science and technology."

Budget limitations prevent DOE from supporting all of the Fusion Committee's recommendations. The department states: "fiscal constraints, in FY 1991 and beyond, have made it impossible to implement even [the commission's] recommended fusion policy with support not available even for a minimum budget case recommendation. These constraints have required the program to prematurely narrow its focus on the tokamak concept, including tokamak improvement activities, and to cut back on the alternate confinement program elements." Five experimental programs will be closed in FY 1991, including the cancellation of a facility at Los Alamos National Laboratory.

Under this budget, the allocation for operating expenses would increase by 15 percent, or $42.6 million, to $321.6 million. The capital equipment budget would decline by 1 percent, or $61,000, while the construction budget would decline by 40 percent, or a reduction of $3 million, to $4.6 million.

The National Science Foundation:

The National Science Foundation is an important source of funding for physics research, although on a much smaller scale than the Department of Energy. For many physicists, NSF is the primary source of support for small science.

There has been little growth in funding for the physics "subactivity" in the last few years. Every year NSF sends a Current Plan to Congress outlining the allocation of its appropriation among its programs and activities. The FY 1990 plan increased funding for the physics subactivity by about 1 percent. The FY 1991 plan increases physics funding by 4.2 percent. NSF's FY 1991 budget increased by 11.2 percent over the previous year.

Physics Subactivity Support

NSF supports research in elementary particle physics; nuclear physics; atomic, molecular, and optical physics; theoretical physics; and gravitational physics. Physics funding is also provided under the separate Materials Research Subactivity.

Although NSF physics funding is overshadowed by the Department of Energy, the foundation plays an important role in university funding. The NSF budget document notes:

> "NSF support of elementary particle and nuclear physics merits special note. Although the Department of Energy has a dominant role in the overall funding of these fields, the crucial role of NSF is evident in university funding. In overall federal support, NSF provides about 8 percent of the funding for elementary particle physics research and about 15 percent for nuclear physics research. However, in support for academic research, NSF provides about one-third and one-half of the support for these fields, respectively."

For the physics subactivity, NSF requested a 10.1 percent increase for FY 1992. This $13 million increase would bring the total budget to $142.03 million.

The National Science Foundation has five different program elements under the physics subactivity. Proposed budget increases for FY 1992 are as follows:

- *Elementary particle physics*: A proposed 11.6 percent increase of $4.9 million for a total budget of $47.23 million.

- *Nuclear sciences*: A proposed 9.7 percent increase of $4.15 million for a total budget of $47.15 million.

- *Atomic, molecular, optical physics*: A proposed 10 percent increase of $1.5 million for a total budget of $16.5 million.

- *Theoretical physics*: A proposed 9.9 percent increase of $1.8 million for a total budget of $19.95 million.

- *Gravitational physics*: A proposed 6.2 percent increase of $0.65 million for a total budget of $11.2 million.

The NSF budget document concludes that "individual and group research activities across all disciplinary programs receive an increase of $7.50 million above the FY 1991 total of approximately $80 million."

NSF highlighted several programs as "special research initiative areas," such as cosmology, complex systems and chaos, and cosmic ray detector development. On-going support is provided for the development of the Fly's Eye, an ultra-high energy cosmic ray detector.

The foundation proposes increases for the upgrading of major facilities such as the Cornell Electron Storage Ring and the Indiana University Cyclotron Facility. Facilities support will be approximately $45 million.

Materials Research Subactivity Support

Substantial support is provided for physics research under the materials research subactivity. This subactivity would receive an 11.4 percent increase, resulting in a new budget of $136.58 million. Program elements within this subactivity are as follows (all figures are approximate):

- *Condensed matter physics*: A proposed 13.2 percent increase of $2.86 million for a total budget of $24.45 million.

- *Solid-State Chemistry and Polymers*: A proposed 12.5 percent increase of $2.25 million to $20.2 million.

- *Metals, ceramics, and electronic materials*: A proposed 18.3 percent increase of $4.14 million to $22.58 million.

- *Materials theory*: A proposed 10.4 percent increase of $1.35 million to $13 million.

- *National facilities and instrumentation*: A proposed 7.5 percent increase of $1.4 million to $18.55 million.

- *Special programs in materials*: A proposed 5.6 percent increase of $2 million for a total budget of $37.8 million.

A high priority of NSF's materials research subactivity will be to "enhance support for fundamental research in areas such as synthesis and processing of advanced materials, particularly biomolecular, electronic, and photonic materials." An increment of $10.6 million will be provided for this activity, of which $1 million is for an increase in high temperature superconductivity. Superconductivity would receive a total of $15.4 million.

Major Research Equipment Subactivity Support

Another area of foundation support for physics-related research is in the area of major research equipment. There are two facilities of particular interest. The first is the Laser Interferometer Gravitational Wave Observatory. NSF requests $23.5 million for the first year of a five-year project with a total estimated cost of $211 million. NSF has requested start-up construction funding for this facility in the past without success.

The second facility is the National High Magnetic Field Laboratory. This is also a five-year project; NSF is requesting $12 million in FY 1992. Half of the anticipated $120 million cost of this project will be provided by the state of Florida.

The National Institute of Standards and Technology:

This Department of Commerce agency is requesting substantial increases for core NIST research programs of interest to the physics community. These include light wave technology, advanced semiconductor measurement issues, and superconductivity. Overall NIST funding would increase by $32.7 million to $248 million, an increase of 15 percent.

The NIST "Budget in Brief" states that "physics research at the Institute includes long-term studies that provide the science base for future generations of measurement technology. It is high-risk research that industry, with its emphasis on proprietary results and short-term returns, is reluctant or unable to support."

NIST's physics program request totals $26.5 million. Proposed research includes:

- "manipulation and measurement of individual atoms or molecules with the goal of producing and characterizing unusual microstructures.
- "improvement in radiation dosimetry and development of a national network of regional calibration facilities to serve an industry growing at 20 to 30 percent per year.
- "development of new technologies for precision optical radiometry used in applications from remote sensing to color graphics; and
- "continuation of efforts to improve the accuracy and precision of time and frequency standards...."

NIST is also proposing a $28.6 million materials science and engineering budget, an increase of 8.2 percent over the previous year. In addition, the Institute is requesting $1.7 million under a different program area for superconductivity research.

The Department of Defense:

The Department of Defense no longer provides specific information on physics-related support in its budget request. Readers are urged to consult the "R&D in the FY 1992 Department of Defense Budget" chapter found elsewhere in this report for an overview of DOD's request.

Chapter 13

Astronomy in the FY 1992 Budget

American Astronomical Society

Peter B. Boyce

I. Highlights of the Astronomy Budget

As presented to Congress, the President's budget for science is very generous. Funding for astronomy shares in this generosity. As in other sciences, the astronomy portion of the budget seems to offer some relief to the plight of the individual investigator. In this budget NSF is emphasizing the need to turn around the past trend toward shrinking size for individual research grants. NSF has earmarked a reasonable-sized increase to make this happen in astronomy.

This is only the asking budget. How the congressional actions will eventually play out is a very important question. In a repeat of last year's scenario, larger scale budget uncertainties and budgetary pressures may force Congress to cut back these requests.

- Within NSF, a special budget line for Major Research Instruments contains $16 million for continuing the construction of a pair of modern 8-meter optical telescopes with British and Canadian participation.
- Although unsuccessful last year in getting congressional approval, NSF is again proposing a small start for a laser interferometer gravitational wave observatory.
- NASA's budget has no new starts in Physics and Astronomy or Planetary Exploration, but otherwise looks relatively healthy.
- The Comet Rendezvous/Asteroid Flyby (CRAF) and the CASSINI mission to Saturn will receive a major increase as the mission enters the major development phase.
- The Advanced X-ray Astronomy Facility (AXAF) will be delayed by about ten months. The funds saved now will be made available for increased engineering efforts on the Hubble Space Telescope (HST).

II. Introduction

As in previous years, we will limit our analysis of the astronomy budget to the two agencies which provide over three-quarters of the federal funding for astronomical research, NASA and NSF. These agencies supply virtually all of the federal funding for individual research grants. Other agencies, such as the Smithsonian Institution, the Department of Defense, the Department of Energy, etc. also fund research of interest to astronomy, but they play a smaller role in the picture of federal support for astronomy. In general, their funding is restricted to support of their own research projects.

III. Astronomy in the NASA Budget

Astronomy in NASA is included in both their Physics and Astronomy and their Planetary Exploration programs. Physics and Astronomy, however, also includes other space physics programs, making it nearly impossible to separate the funding for astronomy from the other programs under this heading, such as Plasma Physics.

The NASA budget tables are given elsewhere in this volume. The following NASA budget lines may need explanation:

Spacelab Payload Mission Management provides support for the planning, integration and execution of all Spacelab and attached shuttle payloads. This includes payload specialist training, payload flight operations and data dissemination to the experimenters.

Space Station Planning and Payloads includes the planning and definition of attached payloads suitable for deployment on the Space Station.

Payload and Instrument Development is designed to accommodate development of specific instruments to be flown on the shuttle, as free-flyers or on foreign flights.

Mission Operations and Data Analysis supports the operating costs of current missions and funds the analysis of data from current and past missions. The entire scientific output of a mission is supported by these funds.

Research and Analysis supports general research relevant to NASA's missions and provides the advanced technology development needed to plan future missions. Funding for early exploratory work on the difficult, pacing items for future missions, such as the Space Infrared Telescope Facility (SIRTF), fall in this budget line as does the Astrophysics Theory Program and grants to individual investigators.

Suborbital Programs supports the flights of aircraft, balloons and rockets. These vehicles provide low-cost platforms for developing instrumentation and provide frequent opportunities for making vital supporting observations.

The FY 1992 NASA budget places strong emphasis upon completion of the ongoing program including augmentations of the research base.

- The Hubble Space Telescope (HST) is now producing science observations on a regular basis. Owing to the need for additional engineering to understand and plan for fixing the problems with the telescope, the mission operation costs are higher than originally planned. The Mission Operations and Data Analysis line is augmented.

- With the difficult mirror fabrication on schedule to meet development and testing milestones, AXAF construction is slated to proceed in 1992. It should be noted that NASA has lengthened the schedule by about ten months beyond the original plans. Funding will be comcomitantly reduced in order to free up funds for supporting the increased engineering efforts needed for dealing with optical problems of the HST.

- The Gamma Ray Observatory, another Great Observatory mission, is essentially complete and is set for launch in April, 1991.

- The Mission Operations and Data Analysis line of the Physics and Astronomy program has a major increase to support scientific use of data from various astrophysics missions, including HST, Cosmic Background Explorer (COBE) and the ASTRO-1 shuttle mission.

- The Suborbital Program has received an increase needed for maintaining a stable level of flights and experimental opportunities.

- The CRAF mission will enter the main construction phase and will receive a major increase in funding.

- The Magellan mission is in orbit successfully mapping Venus. However, there is not sufficient money in the mission operations line for the extended mission needed to complete a much desired second mapping of the planet's surface.

- The Mars Observer mission is proceeding as planned. The mission now includes electronics to relay signals from a Russian balloon scheduled to carry a load of instruments in the Martian atmosphere.

- The Research and Analysis base in Planetary Exploration had sunk in previous years below a viable minimum, necessitating extensive cuts in existing grants. A major increase this year will restore the eroded infrastructure in planetary science and will also bolster the Origins of the Solar System program and the Planetary Exploration Program's ground-based instrumentation.

- The Explorer program has a small increase above inflation. Development of the small explorer missions will continue, although the short time scale from conception to launch has not been achieved as originally envisioned.

- Development of the Extreme Ultraviolet Explorer will continue. Launch is scheduled for the end of this year. The X-ray Timing Explorer will continue, with launch scheduled in 1995. The Far Ultraviolet Spectroscopic Explorer is in the advanced design stage.

IV. Astronomy in the NSF Budget

Astronomy support at NSF has a proposed increase which is significantly above the inflation rate for the first time since 1984. Within the National Science Foundation, most astronomical research is supported within the Division of Astronomical Sciences. The support for astronomical research in other divisions is not specifically enumerated and is difficult to separate out. The budget trends for the Division of Astronomical Sciences are indicative the NSF support of astronomy.

Through contractors, NSF operates three National Observatories which are available to qualified scientists under an extensive visitor use program. The National Observatories have major telescopes and some smaller instruments which have a long history of productive use. Under Astronomy Research Support, NSF has a program of peer-reviewed research grants to individual investigators and to research groups located at universities and research observatories.

The NSF FY 1992 budget table for astronomy is given below. The significant aspects are as follows:

- NSF will provide $16 million to continue construction of two modern 8-meter optical telescopes, one in each hemisphere, with British and Canadian participation. The U.S. participation in this project will be handled by NOAO. The British have recently committed to a 25% participation in the project. The Canadians are making progress for a similar participation within their own funding system.

- Exclusive of the 8-meter funds, NSF Astronomy received an overall budget increase of 10.4 percent from 1991. For the first time in four years, this is substantially above the inflation rate.

- Construction of the Very Long Baseline Array will continue at a rate of $8.7 million, which will keep the project on schedule for completion in 1992. Ongoing operations at NRAO will continue to experience the severe budget constraints which have been the norm for the past few years.

- At NAIC, an upgrade of the Arecibo radio telescope will continue as a joint project with NASA. NSF will supply upgrade funds of $3.9 million. The upgrade includes erection of a noise reduction baffle and the design and construction of a highly efficient, all-frequency secondary mirror. The expected 3-to 10-fold improvement in the world's most sensitive radio telescope will keep this venerable instrument competitive for the next decade.

- The NOAO operating funds will include an additional $0.5 million for the Cerro Tololo Interamerican Observatory in Chile, which is severely pinched by inflation and exchange rate problems in that country. The general operating funds for the observatories have remained at the same dollar value since 1984, an effective cut of 25 percent. The proposed increase for 1992 is greater than inflation. This should begin to provide relief from the severe operational budget constraints which have reduced the efficiency of operation during the past several years. The construction of the solar Global Oscillations Network will continue at a modest pace.

- In the Astronomy Project Support Section, which funds the university grants, the 12.3 percent increase will go in part toward increasing the size of individual grants. There will also be an increase in the support of a program of active optics designed to remove some of the deleterious effects of the earth's atmosphere. The active optics program will receive a boost by the expected imminent declassification of some advanced military research and hardware.

Within the Astronomy Project Support Section, the distribution of money among the programs is driven by proposal pressure and by transfer of responsibility for the larger grants from program to program as the emphasis shifts from instrumentation to research on stars, or to extragalactic research, or back to instrumentation. The budget requests for the individual programs of research grants generally do not reveal specific shifts in emphasis by the agency and, therefore, have not been listed separately.

NSF Astronomy Funding (in millions of dollars)

	FY 1990 Actual	**FY 1991 Plan**	**FY 1992 Request**
Total NSF Astronomy	$ 91.514	$ 97.32	$ 107.42
Astron. Project Support	30.689	31.73	35.63
National Observatories	60.825	65.59	60.80
NAIC	6.219	8.18	10.38
NOAO	24.402	25.91	28.01
NRAO	30.204	31.50	33.40

Chapter 14

FY 1992 R&D in the Atmospheric and Oceanic Sciences

American Meteorological Society

H. Frank Eden

INTRODUCTION

Again in FY 1992 budgets for Atmospheric and Oceanic Sciences are affected by two activities that tend to make the distinction of funding between the two disciplines more difficult than in previous years. The first of these is the latest report of the interagency Committee on Earth and Environmental Sciences' coordinated, interdisciplinary U.S. Global Change Research Program for FY 1992. This cross cuts many agency budgets in an interdisciplinary fashion. Tracking into the disciplines is still possible in most agencies but complicated. The program grows by 24.2 percent over the FY 1991 level to $1.19 billion in FY 1992 with the largest increases in Observations and Data Management. Secondly, in NASA the Earth Sciences and Applications Division of OSSA has reorganized along interdisciplinary lines, merging the old disciplinary research and analysis funds, and including the Earth Observing System, EOS, which is a multi-disciplinary system for observing and documenting the change of many global variables. Some missions such as UARS and TOPEX can still be assigned on a disciplinary basis but a large portion of the NASA budget cannot be so assigned in FY 1992. Accordingly, the usual cross cut table is included in this chapter but not totalled and without a NASA line. In general, however, it is clear from all agency budgets that the FY 1992 proposal requests significant increases for both disciplines.

At NSF, Atmospheric Sciences increases by 15.9 percent from $114.5 million in FY 1991 to $132.9 million in FY 1992. Ocean Sciences increases by 14.4 percent from $164.8 million in FY 1991 to $188.5 million in FY 1992.

At NASA, support in the Earth Science and Applications Program increases, due to increases for EOS and Earth Probes by 16.1 percent from $667.9 million in FY 1991 to $775.6 million in FY 1992. This includes $51.9 million for TOPEX and $18.2 million for UARS. The Earth Observing System, EOS, increases by 63.4 percent to $253.4 million and the EOS data system by 129.4 percent to $82.6 million. Earth Probes (NSCAT, TOMS and TRMM) increase by 24.6 percent to $68.2 million. Upper atmosphere research is now supported through Physics and Astronomy and includes $65.3 million for the Global Geospace Science Mission.

At NOAA, the budget proposal for FY 1992 of $1.59 billion in direct obligations for Operations Research and Facilities represents an increase over the FY 1991 base of $1.47 billion. There are increases in the National Weather Service, the National Environmental Satellite, Data and Information Service and in the National Ocean Service and decreases in Oceanic and Atmospheric Research and National Marine Fisheries Service. The budget includes $78.0 million for Climate and Global Change.

National Aeronautics & Space Administration (NASA)

NASA's overall budget increases by 13.6 percent to $15.7 billion in FY 1992 and provides for two major new initiatives -- a new heavy launch system to be developed jointly with DOD, and LIFESAT, a multi-launch recoverable biosatellite. It continues the development of EOS and the Earth Probes. The Earth Science and Applications Program shows reduced project costs in FY 1992 for the Ocean Topography Experiment, TOPEX, ($51.9 million) and the Upper Atmosphere Research Satellite, UARS, ($18.2 million). Support for the essentially completed Scatterometer is continued in the Earth Probes budget in anticipation of the instrument flying on the Japanese ADEOS project in 1995. The old Research and Analysis disciplinary funds are now contained in Modeling and Data Analysis, Process Studies and Interdisciplinary research, and show a modest decrease of 2 percent to $161.8 million.

For consistency with previous years, programs that relate to upper atmosphere research now contained in the Physics and Astronomy Program are noted also. The Global Geospace Science Mission decreases to $65.3 million in FY 1992, as part of the U.S. contribution to the International Solar Terrestrial Physics Program, ISTP. Approximately 20 percent of the Research and Analysis support in the Physics and Astronomy Program is for space science. Similarly, a significant portion of the Sub Orbital Program of sounding rockets, airborne science and balloon launches is in support of atmospheric sciences.

National Science Foundation (NSF)

The overall FY 1992 request for NSF is at $2.72 billion, an increase of 17.5 percent over the FY 1991 appropriation. This is in line with the Administration's commitment to doubling the NSF budget over five years.

Increases in Atmospheric Sciences Project Support in FY 1992 are primarily in portions of the Global Geosciences initiative (which increases by $11 million to $33.1 million), including enhancements for major field programs in the Global Tropospheric Chemistry Program, and the Tropical Ocean and Global Atmosphere (TOGA) program, the initiative of a program to quantify the radiative effects of clouds on a global scale, and modeling and data management efforts.

The Upper Atmosphere Facilities program will provide enhanced support ($0.4 million) for CEDAR. At NCAR, an increment of $7.6 million will emphasize Global Geosciences programs and increased cost of operations.

Of the FY 1992 increment of $23.70 million in Ocean Sciences, Global Geosciences programs will receive $13.2 million for WOCE, JGOFS, the Global Ocean Ecosystem Dynamics Program, GLOBEC, and TOGA-COARE.

In the Ocean Drilling Program, ODP, incremental support will emphasize high temperature techniques, high latitude programs and increased analysis of logging data. Increases in the Centers and Facilities Program will support Global Change field programs, new instruments and upgrading of one intermediate sized research vessel.

The above figures do not include support for the Atmospheric and Oceanic Sciences from the Division of Polar Programs. In the Arctic Research Program the FY 1992 level of support for research projects is $17.2 million of which about 30 percent is for atmospheric and oceanic research. The increase of $2.6 million over FY 1991 is in support of the Arctic Systems Sciences effort, ARCSS and Arctic social science. The ARCSS increase emphasizes Arctic Ocean research and land-atmospheric research. Antarctic Program support for atmospheric and oceanic research is approximately 40 percent of the Antarctic Research Program's budgets of $22 million in FY 1992 with an increase across the geosciences.

Department of Defense (DOD)

The budget projections for DOD are estimates based upon FY 1990 obligation, FY 1991 organizational budgets and the FY 1992 budget submission. The FY 1991 and the FY 1992 estimates are subject to change.

Army research in atmospheric sciences focuses strongly on the planetary boundary layer and support to army weapon systems. Research includes theory and technique development to document atmospheric effects on electro-optical and infrared propagation, focusing on the battlefield environment. Research in airflow in complex terrain and atmospheric transport and diffusion addresses a broad front of Army and DOD needs. Exploratory work to evaluate new sensor technologies, such as profiler radar and lidar, continues in efforts to develop battlefield remote sensing capabilities. A centerpiece of the Army development program is the integration of weather events and effects into the Air-Land Battle concept. A substantial effort to develop standard scenes for the evaluation and testing of weather sensitive smart weapons is not included in budget summary, but would add about $5 million each year, if classed as atmospheric sciences.

The Air Force research program also focuses on a wide breadth of research needs. In large scale dynamic modeling, the fidelity of Air Force global and regional prediction models for highly reliable cloud forecasting is being emphasized. On a more limited scale, research is continuing on refining atmospheric electro-optical and infrared propagation codes and the development of electro-optical/infrared systems tactical decision aids. In other areas, emphasis is being placed on satellite and ground-based remote sensing capabilities such as satellite vertical sounding for temperature and water vapor, upper atmospheric density, and the development of algorithms for the NEXRAD radar. Technology development continues in the area of advanced meteorological data processing incorporating expert systems concepts to fuse data from various sources, i.e. radar, satellite and other ground-based sensors.

Atmospheric science research funded by ONR consists of two primary thrusts, marine planetary boundary layer and oceanic storms. Marine boundary layer research is directed toward understanding the physical processes governing the evolution of the lowest 2 km of the atmosphere over the ocean and in coastal regions. Oceanic research has two major components, midlatitude extratropical cyclogenesis and western Pacific tropical cyclones. In other areas, efforts are underway to introduce new capabilities in meteorological and oceanographic data acquisition, processing and presentation through the introduction of the third generation Tactical

Environmental Support System (TESS-3) to major combatant ships.

Oceanographic research includes small scale physical oceanography, mesoscale and large scale circulation and structure, ocean geophysics (bottom characterization, thermal vents), ocean acoustics (noise sources and character, acoustic propagation), and ocean biology. Ocean circulation efforts ultimately focus on the development of eddy resolving global and regional oceanographic numerical models. The increase in FY 1992 is reflective of emphasis being placed on ocean sciences by ONR.

Not specifically included in the budget table is funding for the DOD University Initiative (URI) programs in atmospheric and ocean sciences. In FY 1992, approximately $8.8 million is funding URI programs in atmospheric, ocean and space environmental sciences.

National Oceanic & Atmospheric Administration (NOAA)

The NOAA request for FY 1992 of $1.59 billion for Operations, Research and Facilities represents a significant increase over FY 1991 obligations. There is a significant reductions in the National Marine Fisheries Service, increases in the National Weather Service, and National Environmental Satellite, Data and Information Service and a reduction in Oceanic and Atmospheric Research. Significant increases are proposed for Climate and Global Change and Coastal Ocean Science.

In the National Ocean Service, the Ocean and Coastal Management program activities are reduced. The Coastal Ocean Science program increases by $7.0 million to $17.4 million.

In the National Marine Fisheries Service almost all programs have been reduced.

In Oceanic and Atmospheric Research, the Climate and Global Change program funding is $78 million, an increase of $30.8 million over FY 1991; PROFS research is reduced by $1.9 million; Regional Climate Centers; Weather Modification Grants; Seafloor Processes Research; Undersea Research; and the National Coastal R&D Institute are terminated. Sea Grant is reduced by $15.4 million to $24.9 million.

The National Weather Service is proposed for an increase of $48 million. NEXRAD and related procurements increase by $19.7 million and acquisition of AWIPS and NOAA PORT equipment is increased by $34.5 million. The Special Agricultural Weather Services are terminated.

In the National Environmental Satellite, Data, and Information Services (NESDIS), the FY 1992 request increases by approximately $124.6 million and provides for maintaining a geostationary satellite (GOES) system and a polar-orbiting satellite system and the procurement of the next series of satellites and the maintenance of Landsat 5.

Program Support increases by approximately $3.1 million in FY 1991. DAVIDSON and ALBATROSS are deactivated and the procurement of navigation system components for the P-3s is completed.

Other Agencies

Atmospheric Sciences:

In EPA funding for atmospheric research remains stable for FY 1992 except for additions for Clean Air Act (CAA) resources. The CAA funding associated with the atmospheric sciences program has not been delineated at this time.

In DOA, the increase in the FY 1992 budget reflects an expanded program aimed generally at global change issues including UV-B studies, significant increases in long term forest monitoring and ecosystem modeling and biogeochemical cycles. The rest of the budget supports basic research in climatology, upgrades to the SNOTELL joint agricultural weather facility, strengthened meteorological data handling and regional hydrological modeling and validation.

The DOE program in atmospheric sciences of the Office of Health and Environmental Research (OHER), covers over 97 percent of the total DOE budget in the atmospheric sciences. The major portion of the OHER budget involves studies dealing with global change including the atmospheric radiation measurement, ARM, program, the computer hardware advanced mathematics and model physics, CHAMMP, program and a number of other studies with budget figures increasing from $33 million in FY 1990 to $52 million in FY 1992. Atmospheric research in OHER also consists of atmospheric chemistry studies, the atmospheric effects of complex terrain, and emergency response research.

In BUREC, the weather modification program has not been funded since FY 1979 except for reimbursable work. Other Department of Interior programs, effects of biological pollutants, acid deposition monitoring, and modeling, are stable at about $10 million annually. A major portion of this research centers on the visibility studies for Class I areas of National Parks; the 1990 Clean Air Act includes an authorization of $8.0 million into the causes of such visibility reductions. These programs have generally not been reported in this analysis.

Ocean Sciences:

In the U.S. Geological Survey, there was an increase in FY 1991 in the Coastal Erosion and Wetland Loss Program, and a slight increase in funding for EEZ and geological framework studies. There is essentially no change in FY 1992 in offshore geologic framework studies, in EEZ research, and a possible slight decrease in coastal studies.

In DOE, the funds support improvement and validation of models of the ocean/atmosphere system and the carbon cycle. This aspect of the program is enhanced in FY 1992. Cycling of carbon on the continental shelf and exchange with the open ocean will continue to be analyzed through basic oceanography. Cooperation with WOCE and GOFS will continue.

Research projects supported through the Environmental Studies Program, ESP, of the Minerals Management Service (MMS) provide the information necessary for the MMS to make environmentally sound decisions concerning leasing and exploitation of oil and gas resources in the U.S. Exclusive Economic Zone. These studies are classified in nine topic areas with emphasis on biology, endangered species, fates and effects, and physical oceanography with the majority of the studies contracted out as competitive procurements.

MMS's FY 1990 and planned FY 1991 and FY 1992 ESP budgets exceed $20.0 million per year with modest increases between fiscal years. The program is very heavily ocean directed. A major new initiative will begin to describe the physical oceanography of Southern California. Also beginning in FY 1991, there will be an increased emphasis on air quality studies for California and the central and western Gulf of Mexico. The program is reported here totally as oceanic.

The Environmental Protection Agency, EPA, supports a program of Coastal Environmental Management to provide scientific and technical support for state and local management of coastal water quality in response to risks due to pollution and loss of habitat. Regional efforts are focused on the Great Lakes and the interagency Coastal America Program.

Table 1. R&D in the Atmospheric and Ocean Sciences (Budget Authority in millions of dollars)

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
Atmospheric			
NASA[1]	-----	-----	-----
NSF	104.2	114.5	132.9
DOD	67.7	63.8	68.9
DOC (NOAA)	101.6	127.7	167.2
DOE	46.6	58.5	65.5
EPA	20.4	20.5	20.5[2]
DOA	25.8	39.3	46.3
Oceanic			
NASA	-----	-----	-----
NSF	147.4	164.8	188.6
DOD	88.1	94.9	101.8
DOC (NOAA)	81.7	89.3	78.5
USGS	32.4	37.7	30.9
DOE	8.5	9.5	12.2
MMS	20.0	23.3	23.3
EPA	21.1	35.5	49.2

[1] It is not possible to divide the FY 1992 NASA budget accurately between the two disciplines.

[2] Excludes Clean Air Act research resources.

Table 2. R&D in NASA's Atmospheric and Ocean Sciences

Earth Science and Applications

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
Earth observing system	(74.0)	155.0	253.6
EOS data information system	-----	36.0	82.6
Earth probes (including Scatterometer)	13.6	54.7	68.2
Remotely piloted aircraft	-----	-----	5.0
Upper atmosphere research satellite mission	55.2	64.0	18.2
Ocean topography experiment	84.8	76.0	51.9
Payload and instrument development	76.1	49.7	48.6
Mission operations and data analysis	23.8	39.4	56.3
Interdisciplinary research	8.6	12.4	2.5
Modeling and data analysis	38.5	44.3	45.0
Process studies	106.2	107.5	114.3
Research facilities	27.4	28.9	29.6
TOTAL	434.2	667.9	775.8

Physics and Astronomy Program

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
Global geospace science	57.6	96.6	65.3
Research and analysis	104.9	100.8	103.1
Suborbital program	52.7	55.0	61.0
Mission operations and data management	215.7	313.3	388.4
TOTAL	430.9	565.7	617.8

Table 3. R&D in NSF's Atmospheric Sciences

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
Atmospheric Science Project Support	53.1	59.6	69.6
National Center for Atmospheric Research	45.5	48.5	56.2
Upper Atmospheric Research Facilities	5.6	6.4	7.1
TOTAL	104.2	114.5	132.9

Table 4. R&D in NSF's Ocean Sciences

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
Ocean Sciences Project Support	72.9	82.1	97.7
Oceanographic Centers and Facilities	42.5	47.7	54.5
Ocean Drilling Program	32.0	35.0	36.4
TOTAL	147.4	164.8	188.6

Table 5. R&D in DOD's Atmospheric Oceanic Sciences

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
Atmospheric Sciences			
Army	16.7	15.2	15.4
Navy	20.3	19.2	18.6
Air Force	30.7	29.4	34.9
Subtotal	67.7	63.8	68.9
Oceanic Sciences			
Navy	88.1	94.9	101.8

Table 6. The National Oceanic and Atmospheric Administration

	FY 1990 Actual	FY 1991 Estimates	FY 1992 Estimates
National Ocean Service	144.6	151.8	157.3
National Marine Fisheries	186.3	212.2	174.6
Oceanic & Atmospheric Research	171.8	208.7	186.8
National Weather Service	426.0	476.0	508.6
NESDIS	264.3	274.7	406.7
Program Support	134.2	148.9	156.3
TOTAL	1,327.2	1,472.3	1,590.3

Chapter 15

Earth Sciences in the FY 1992 Budget

American Geological Institute

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Most geoscience research programs are showing at least modest increases in funding for fiscal year 1992. The most substantial increases are in agencies involved in global change studies, groundwater protection, and oil recovery research. Budget information presented in this report will focus on increases or decreases in funding for programs having significant geoscience components. More detail is provided for bureaus or agencies whose primary function centers on geoscience programs.

Department of Interior

Bureau of Land Management

The Bureau of Land Management (BLM) has mineral and surface management responsibilities on approximately 270 million acres of public lands in 28 states. BLM also administers mineral leasing and supervises minerals operations on 300 million acres of Federal mineral estate underlying other ownerships throughout the United States. BLM uses geoscience information in many of its programs, especially those related to resources evaluation. An increase of $2 million has been proposed for the Spoil, Water, and Air Management program for Global Climate Change research.

Minerals Management Service

The Minerals Management Service's principal geoscience activities are related to its role as the manager of energy and mineral resources on the Nation's Outer Continental Shelf (OCS). Geologic studies are carried out as part of the Resource Evaluation program and as a small component of the Environmental Studies Program. Most are carried out in support of the OCS oil and gas leasing program with some support provided for evaluation of hard-mineral resources in the Exclusive Economic Zone (EEZ). President Bush's call for a more carefully targeted OCS Program and the need for increased environmental information in OCS areas presently under moratoria or deferred by Presidential action has led to increased funding for some geology-based programs. Most notable are an increase of $7.93 million (to $22.3 million) in Resource Evaluation and $15.5 million (to $56.5 million) in Leasing and Environment. The latter increase includes $0.4 million for a new Global Change study.

Bureau of Reclamation

This bureau manages water projects and programs in the 17 western states. Its Science and Technology program, which includes studies related to Global Change and groundwater recharge has a proposed increase of $1.7 million (to $15 million).

U. S. Geological Survey (USGS)

As the primary federal geoscience research organization, the USGS carries out investigations, including mapping, that lead to a better understanding of the Nation's land, energy, mineral, water, and environmental resources. Its programs are carried out through three divisions: Geologic Division, Water Resources Division, and National Mapping Division supported by an Information Systems Division and an Administrative Division. The total USGS 1992 budget estimate shows a $7.1 million decrease (to $564.1 million) compared to the FY 1991 appropriation and a $25.3 million decrease compared to the 1992 base budget.

The overall change in the National Mapping Division budget, which supports topographic map and digital data production, information and data systems, research and technology, and advanced cartographic systems is a decrease of $0.2 million (to $135.7 million). The Geologic Division Budget, which includes geologic hazards surveys, geologic framework and processes studies, global change research, offshore geologic surveys, mineral resource surveys, and energy geologic surveys, is decreased $24.4 million (to $203.5 million). The Water Resources Division budget is decreased by $5.6 million (to $176 million).

The most significant decreases (from 1992 base amounts) are in programs dealing with the physical environment, principally with hazards and coastal land loss. The Earthquake Hazards Reduction program is reduced by $15 million and the Volcano Hazards program by $4.1 million for an overall Geologic Hazards reduction of $19.1 (to $52 million). The Coastal and Wetlands Processes program is reduced by $7.5 million. The largest increase is in an environmental program in the Water Resources Division where the National Water-Quality Assessment (NAWQUA) program is increased by $10 million. This is offset by decreases in the Water Resources Division budget of $6 million (to $62.1 million) in the Federal/State Cooperative program portion of the National Water Resources and Information System program and $5.6 million (to $176 million) in the State Research Institutes and Research Grants program.

Global Change research in the Geologic Division is increased by $1 million and the Global Change Data Systems program in the National Mapping Division is increased by $2.1 million. The Global Change Hydrology program in the Water Resources Division is increased by $0.7 million. The cumulative increase in USGS Global Change programs is $3.8 million.

U. S. Bureau of Mines

The Bureau of Mines carries out information and research programs related to the U.S. domestic supply of mineral resources and gathers and analyzes international mineral resource information. It carries out very little geologic research, however geologic information plays an important role in its programs. The overall Bureau budget for FY 1992 shows a $26.7 million decrease (to $156.1 million) from 1992 base amount. Two programs absorb this loss, the greatest by far being the $27.3 million decrease (to $78.2 million) in the Research program, which includes health, safety, and mining technology; minerals and materials science; and environmental technology. The second is the decrease of $5.7 million (to $4.3 million) in the Mineral Institutes where allotment grants are discontinued while research grants and program administration are maintained.

U.S. Department of Energy

Geoscience programs are spread throughout the Department of Energy. While most are related to energy supply, there are strong geoscience components of waste disposal programs. The largest geoscience research program is in Basic Energy Sciences (BES). For 1992 the request for the BES program is $714.7 million, an increase of $2.9 million over the 1991 budget authority. The engineering and geosciences component of this request is $35.8 million. Most of the global change research at DOE is carried out under its Biological and Environmental Research program, which is requesting $77 million for its part of the DOE global change effort in FY 1992.

The largest DOE geoscience activity is in the Nuclear Waste Disposal program where site characterization at Yucca Mountain in Nevada is budgeted at $172.2 million for FY 1992. DOE has made a major commitment to environmental restoration and waste management related to DOE facilities and disposal sites. This is the fastest growing program area in the Department with a $4.7 billion request for FY 1992, an increase of $43.1 million over 1991. Geotechnical considerations are an important part of this effort.

The Energy Supply Research and Development program includes geothermal energy research budgeted at $20.2 million for FY 1992, a decrease of $7.1 million. Some of this funding goes for geoscience-oriented resource characterization and production research. The Fossil Energy Research and Development program is dominated by coal projects ($115 million), but includes $8 million (a decrease of $7.8 million) for unconventional gas recovery and $52.2 million (a decrease of $6.9 million) for petroleum which includes oil shale. A significant part of the gas and petroleum subprograms is geoscience oriented whereas the coal subprogram contains very few geoscience components. The only increases requested in the Fossil Energy program are for environmental restoration (from $0.7 to $8.1 million) and the oil recovery and advanced extraction and process technology activities (from $41.7 to $52.2 million). Both of these have major geoscience elements.

National Science Foundation

The National Science Foundation, an independent agency of the Federal Government, was established to promote and advance the progress of science in the United States, primarily by providing support for basic scientific and engineering research and by supporting activities in science and engineering education.

The NSF budget request for FY 1992 is $2.72 billion, a 17.2 percent increase above the FY 1991 appropriation of $2.32 billion. The requested budget emphasizes individual investigators and the research infractructure.

NSF funding in the geosciences is largely in the domain of the Geoscience Directorate, which includes divisions of Atmospheric, Earth, Ocean, and Polar sciences. Organizational changes in 1990 included restructuring that focused on the increased awareness of the growing demand for human resources in science and technology, and the need for increased scientific literacy; such changes including the emplacement of a staff person for education and human resources in most of the scientific subdivisions, including Earth sciences.

The disciplinary focus for budget increases in the Geoscience Directorate includes global change research, for which $118 million has been requested for FY 1992. The FY 1992 request also continues NSF support of the Antarctic program, including $22 million for Antarctic research; the total request for this program totals $193 million, an increase of $18 million.

GEOSCIENCE DIRECTORATE
(in millions)

Division	FY 1992	Change	FY 1991
Geosciences	$419.5	14.1 %	$367.7
Atmospheric	132.8	15.9 %	114.5
Earth	74.7	9.3 %	68.3
Ocean	188.5	14.4 %	164.8
Arctic Res.	17.7	18.4 %	15.0
Sci/Tech Ctrs.	5.9	15.7 %	$5.1

National Aeronautics and Space Administration

The NASA budget request for FY 1992 is $15.7 billion, a 13.7 percent increase over the current appropriation ($13.8 billion). Mission to Planet

Earth remains a high priority. Other continuing earth science-related programs include the design and development of EOS-A instruments, and the high-focus Earth probes, including a Tropical Rainfall Measurement Mission and another Total Ozone Measurement Spectrometer. These programs are part of the research and development budget for which NASA requested $7,198.5 million, a 19.5 percent increase over FY 1991.

Program	FY 1992	Change	FY 1991
R&D	$7,198.5	19.5%	$6,023.6
Earth Science	775.6	16.1%	667.9
EOS	336.0	75.9%	191.0
Earth probes	$68.2	24.6%	54.7
Upper Atmosphere Research Satellite	18.2	-71.5%	64.0
Ocean Topograpy	51.9	31.7%	76.0

U.S. Department of Agriculture

The Department of Agriculture has submitted a modest increase request for its FY 1992 research and development budget. This 3 percent increase over enacted FY 1991 levels raises the R&D budget by $37 million and brings it to $1,261 million. There will be a general continuation of Agriculture's R&D activities, but a few programs are to receive special emphasis. As part of its involvement in the National Research Initiative, USDA has increased its commitment by $52 million (71 percent) over 1991 levels. Among the programs to be intensified are environmental responsibilities and more rational use of natural resources, focusing especially on water quality and global climate change. Hazardous-waste management will be a particular focus of the Forest Service and the Agricultural Research Service, which handle over 90 percent of USDA's hazardous-waste compliance activities. Other targets include leaking underground storage tanks, potential discharge of toxic wastes from abandoned mines, and potential contamination from past discharge of chemicals from research facilities.

Environmental Protection Agency

A 7 percent increase in EPA's operating budget will enhance that agency's efforts in several directions, including implementation of the recent Clean Air Act Amendments, improved enforcement of environmental laws, expansion of environmental education (National Environmental Education Act of 1990) and acceleration of Superfund hazardous-waste cleanup. These all have geoscience components.

EPA's budget would also double its environmental education funding, in addition to $0.5 million for teacher incentives (Presidential Awards for Excellence in Environmental Education).

The proposed $134 million increase for the Superfund hazardous-waste cleanup program will bring the total 1992 resources to $1.75 billion. The emphasis within Superfund activities will shift to actual site cleanup work (increasing by $143 million, 19 percent over 1991 levels), of which the bulk ($107 million) will be directed at permanent remedies at sites.

Chapter 16

Water Resources Research in the FY 1992 Budget

Universities Council on Water Resources

Robert C. Stiefel

INTRODUCTION

Water-related research is included in some way in most of the cabinet-level departments and independent agencies in the federal government, but this examination of the budget for water resources research is limited to the four departments and agencies having a major responsibility for the resource. In the author's opinion these agencies account for over ninety-five percent of the federal expenditures for water resources research. Water research in the marine environment and in the atmosphere is not considered but is included in the Disciplinary Analysis on Atmospheric and Oceanic Sciences.

Funding for water resources research in the federal FY 1992 budget considered in this analysis amounts to $591.5 million. This is an increase of approximately 5 percent of the amount budgeted in FY 1991. Most of the increase is attributable to the government-wide water quality program.

DEPARTMENT OF THE INTERIOR

The 1992 budget continues a presidential initiative to establish the scientific basis for national and international policy-making relating to global change with the establishment of the U. S. Global Change Research Program (USGCRP).

The Department of Interior is requesting $46.4 million in 1992 for its component of the USGCRP, an increase of $9.8 million, or 27 percent, over the 1991-enacted level of $36.6 million. In addition to the Bureaus included in the 1991 USGCRP (BLM, BOR, GS, FWS, and NPS, and OS), the Minerals Management Service and the Bureaus of Mines and Indian Affairs will initiate global change projects in 1992.

The Department of Interior, through the Geological Survey (GS) and in consultation with other federal and state agencies, will continue its implementation of the National Water-Quality Assessment (NAWQA) program in 1992. The program's objective is to describe the status and trends in the quality of a large, representative part of the nation's surface-water and groundwater resources and to provide a sound, scientific understanding of the primary natural and human factors affecting these conditions.

The budget request for 1992 is $28.5 million, an increase of $10.3 million over the 1991-enacted level of $18.2 million, to fund the completion of reports and the conduct of continuing low-level assessment activities in the original seven pilot study units; the progression of the 20 study units selected in 1991 from the planning phase to the date analysis phase; and initiation of reconnaissance sampling on these units. The request will also provide support to begin the integration of water- quality information related to pesticide occurrence at the regional and national level.

Geological Survey

The 1992 request for Water Resources Research and Investigations is $176 million. It includes $28.5 million, an increase of $10.3 million over FY 1991, for the National Water Quality Assessment (NAWQA) program. In 1992, the first 20 studies, begun in 1991, will move from the planning phase to the data analysis phase, all studies will begin reconnaissance sampling, and preparation of national synthesis and topical reports will begin.

Capital improvements will be completed for the water quality laboratory. A $0.8 million increase for Global Change Hydrology will allow additional support for five studies begun in 1991, and initiation of a new river basin sensitivity study in the southeastern United States.

Funding for the Water Resources Research Institutes and Grant Programs are proposed at greatly reduced levels. These reductions will result in a decrease in funding to each of the 54 Water Resources Research Institutes of approximately 51 percent from the FY 1991-enacted levels of $105,000 per Institute to a level of $52,000 per Institute. In addition, the number of research projects funded through the National Water Resources Research Grants program will be reduced from 40 in 1991 to 17 in 1992.

The Bureau of Reclamation

The request for General Investigations is $12.6 million, a decrease of $0.6 million from the 1991 level. General investigations funds are used to study water-related problems in the West and to identify and evaluate a broad range of alternative solutions. Most of the studies emphasize non-structural, management, and conservation solutions to current water resources problems. The studies also emphasize the protection of water quality and fish and wildlife and the preservation/restoration of wetlands.

Fish and Wildlife Service

The Fish and Wildlife Service conducts fish and wildlife research at its 13 laboratories and operates Cooperative Research Units at 38 universities in 36 states. In support of Historically Black Colleges and Universities, the Service is establishing a Cooperative Research Unit at the University of Maryland - Eastern Shore. The decrease of $4.8 million for research is the result of 1991 project completions and limited participation in continuing projects. The Service conducts research and training to improve wildlife management capabilities, improve sport fish productivity, protect species that are endangered or threatened, assist in the implementation of recovery programs, and prevent or minimize adverse environmental effects on fish and wildlife resources.

DEPARTMENT OF THE INTERIOR
(in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget
U. S. Geological Survey			
National Water Resources Research & Information System-			
Federal Program	$ 100.9	$ 102.8	$ 108.7
Federal/State Coop Prog.	65.8	68.0	62.1
State Research Insts.	10.8	10.8	5.2
Total	$ 177.5	$ 181.6	$176.0
Bureau of Reclamation			
General Investigations	$ 6.9	$ 13.2	$ 12.6
Total	$ 6.9	$ 13.2	$ 12.6
Fish & Wildlife Service			
Research and Development-			
Coop Research Units	$ 6.5	$ 7.5	$ 5.7
Fisheries Research	15.0	11.5	11.5
Total	$ 21.5	$ 18.0	$ 17.2

ENVIRONMENTAL PROTECTION AGENCY

The President's 1992 budget provides a total of $491.3 million for EPA's research and development program. This represents an increase of $57.7 million over the 1991 level. Internal shifts of $14.3 million from completed research activities increase the level of funding to $72 million for

new research initiatives in 1991.
The major increases will enhance ecological systems research, help implement the Clean Air Act legislation, support new media research needs, and strengthen the Agency's long-term research capabilities.

Funds for Water Quality Research will be increased by $1.2 million to support wetlands preservation and to support the Great Lakes initiative that includes monitoring fresh water sediments, assessing the impact of the zebra mussel, and studying the sources of toxic chemicals.

Drinking Water Research will continue to develop methods to detect groundwater contaminants, understand and predict their behavior, and assess cost-effective alternatives for cleaning up contaminated groundwater. Additional funds (+$1.5 million) will be provided to conduct studies on drinking water contaminants.

Funds for Hazardous Waste Research will increase by $4.4 million. EPA will expand research on bioremediation and municipal solid waste (MSW), and provide increased site-specific technical information for RCRA corrective actions. Research will continue to evaluate pollution prevention techniques and innovative technologies for municipal waste disposal.

Funds for Multimedia Research (formerly Interdisciplinary Research) will increase $26.5 million to strengthen the Agency's long-term research program, to upgrade scientific research equipment, and to enhance risk based media research.

ENVIRONMENTAL PROTECTION AGENCY
(in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget
Office of Research and Development			
Water Quality	$ 9.8	$ 27.7	$ 28.9
Drinking Water	11.7	20.7	22.2
Hazardous Waste	28.3	39.2	43.6
Multi-Media	65.9	124.2	150.7
Total	$ 114.7	$ 211.8	$ 245.4

DEPARTMENT OF AGRICULTURE

Funds are proposed to continue water quality programs funded in 1991 as part of a coordinated government-wide initiative. Much of the initiative is being targeted to nonpoint source pollution identified in plans developed by states under requirements of Secion 319 of the Water Quality Act of 1987. Agriculture has been identified as a nonpoint source pollution contributor in many states. The major objective of the USDA water quality initiative is to provide farmers, ranchers and other land managers with the information necessary to voluntarily adopt improved, environmentally sound, management practices which do not sacrifice profitability.

The initiative will be evaluated based on water quality impacts expected on production factors, management practices, and costs of achieving water quality improvements.

A $2.8 million increase is proposed for federal and university research programs. Agencies will continue to pursue research in support of goals and objectives outlined in the USDA Research Plan for Water Quality. Projects will be continued in the Midwest Corn Belt, where concentrated corn and soybean production involves widespread use of nitrogen and pesticides in connection with conservation tillage practices. Work will also be expanded to:

- Asess the role of wetlands and stream borders in modifying the movement of chemicals into water
- Develop crop rotation systems and means to use animal wastes to maintain and improve water quality without sacrificing profit ability
- Improve the understanding of transport and deposit of agricultural chemicals in soils and water
- Improve risk assessment with new techniques to assess mutagenic compounds in groundwater.

The USDA is proposing a $13.5 million increase in funding for global change research programs in 1992. Research funding is proposed for federal scientists of ARS, ERS and the Forest Service and for competitive grants to universities to assure that a broad spectrum of expertise will be engaged in developing appropriate solutions to major issues identified in global change plans. Priorities for 1992 research include work to better understand the carbon cycle; development of basic hydrologic models to understand the effects of global change on water availability at local, watershed and regional levels; and research to improve energy systems from biomass fuels.

The Agricultural Research Service conducts basic and applied research at federal laboratories to solve problems encountered by agricultural producers and consumers of farm and ranch products. Research in support of the President's water quality initiative is increased by $4 million in the budget.

The Soil Conservation Service's (SCS) research focus is the development of a sound scientific basis to provide advanced technical assistance and education to producers to manage and conserve soil and water resources. Recent legislation, including the FACT Act and the Clean Water Act of 1987, highlight the need to conserve soil, protect water quality, and preserve vital wetland habitats. Increases for 1992 would build on water quality and global change programs conducted in close coordination with other federal and state research agencies.

The mission of SCS is to improve and conserve soil and water resource quantity and quality, improve agriculture, and reduce damage caused by floods and sedimentation. At the 1992 budget level of $809.3 million, SCS will continue to place top priority on ongoing implementation of the conservation provisions of the FSA of 1985 as well as meeting the new requirements of the FACT Act. This level of funding will also allow continued support for the Administration goals of enhancing water quality and preserving wetlands. Federally funded, agricultural research conducted in partnership with the State Agricultural Experiment Stations (SAES) is administered through the Cooperative State Research Service. CSRS will provide increased funding for university research as part of the USDA water quality program consistent with the USDA Research Plan for Water Quality.

DEPARTMENT OF AGRICULTURE
(in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget
Water Quality Program			
Agricultural Res.	$ 37.5	$ 42.5	$ 46.5
Coop State Res.	25.0	32.6	31.2
Economic Res.	.8	1.8	2.1
Soil Conservation	27.2	29.9	23.6
Total	$ 90.5	$ 106.8	$103.4

NATIONAL SCIENCE FOUNDATION

Water resources related research funded by the National Science Foundation is included in several subactivities within the Engineering and Geosciences Activities. The Biological and Critical Systems and the Chemical and Thermal Systems Programs in the Engineering Activity and the Global Geoscience Program in the Geoscience Activity, which is the focus of NSF's contribution to the U. S. Global Changes Research Program, are the areas primarily doing water resources related research.

NATIONAL SCIENCE FOUNDATION
(in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Budget
Engineering Activity			
Biological/ Critical Systems	$ 5.4	$ 5.9	$ 6.8
Chemical and Thermal Systems	7.5	8.8	9.9
Geoscience Activity	12.5	16.7	20.2
Total	$ 25.4	31.4	36.9

Chapter 17

FY 1992 R&D in the Biological Sciences

American Institute of Biological Sciences

Jennie Moehlmann

Overview

Biological research spans several federal departments and agencies, ranging from biomedical research conducted by NIH and DOE to research on local, regional, and global ecosystems supported by NSF, NOAA, USDA, and EPA. Most biological research programs are scheduled for an increase in FY 1992.

Environmental Protection Agency

EPA's R&D program will grow by 23 percent to $311 million and will focus on clean air, ecological systems, and research aimed at identifying agency priorities. Areas of media-related research involving the biological sciences include:

- Multimedia. The multimedia program, which consists of activities that promote an integrated approach to environmental protection, will see a 25 percent increase to $138 million. Research activities provide support for long-term core research and risk assessment guidelines. Rebuilding of the agency's infrastructure is also included in this category.

- Air. Most of the $23 million increase for air quality (to total $81 million) is for research to implement the 1990 Clean Air Act amendments. Other programs include research on indoor air, global change, and stratospheric ozone depletion.
- Water Quality. Water quality research activities within EPA total over $13 million and are targeted to develop guidelines for establishing site-specific water quality standards. Ecosystem research is performed on oil spills, wetlands, and various types of wastes dumped into the ocean.
- Drinking water. Over $11 million is provided for research efforts to understand the mechanisms of groundwater contamination from the use of agricultural pesticides and fertilizers, and to evaluate the health effects of drinking water contaminants.
- Pesticides. Research activities totaling $8.2 million will continue to focus on risks to human health and the environment from pesticides. Research on biological pesticides also will continue.
- Toxics Research. A 5 percent increase has been allocated to support activities to understand the movement of chemicals into the environment and to determine the effects of these chemicals on both human health and the environment.

Department of Interior

The proposed budget for research and development at the Department of Interior's Fish and Wildlife Service (FWS) decreased from the current level of $81.8 million to $80 million. FWS conducts research to improve wildlife management capabilities, protect endangered or threatened species, assist recovery programs, and prevent or minimize adverse effects on fish and wildlife. FWS plans to begin efforts to manage more than a single rare species by protecting several within the same ecosystems.

National Science Foundation

Although NSF received a 17 percent increase overall, the Biological, Behavioral, and Social Sciences Directorate (BBS) received the smallest percentage increase in funding at 12.8 percent. The total BBS budget requests $355.64 million. Of this amount, $311 million is for individual investigators, an increase of $34 million. Highly competitive beginning investigators will receive five years of support.

BBS supports high-priority research areas including biodiversity, plant sciences, and global change, and it also supports basic disciplinary research. BBS also participates in the NSF initiative focusing on the design synthesis and structural analysis of biomolecular materials.

Funding for the US Antarctic Research Program will increase $3 million to $22 million, providing for an additional long-term ecological research project, expansion of ocean research, and studies of the biological effects of increased ultraviolet radiation due to ozone depletion.

The Research Facilities Modernization program has been replaced by a new initiative designed to provide universities with state-of-the-art research equipment and facilities. This initiative, funded at $50 million, will award grants ranging in size from $100,000 to $2 million with cost sharing of at least 50 percent from nonfederal sources required.

NATIONAL SCIENCE FOUNDATION
Biological Behavioral and Social Sciences

	1991 Estimate (millions)	1992 Request (millions)
Molecular Biosciences		
Biochemistry	$ 14.6	$ 16.1
Biophysics	15.5	17.1
Genetics	21.3	24.3
	51.4	57.5
Cellular Biosciences		
Cell Biology	16.6	18.6
Cellular Biochemistry	13.1	14.9
Developmental Biology	15.4	16.1
Physiological Processes	15.9	18.4
	61.0	68.0
Biotic Systems and Resources		
Ecology	11.3	12.7
Ecosystem Studies	25.9	28.5
Systematic Biology	14.5	15.9
Population Biology and Physiological Ecology	12.0	13.4
Biological Research Resources	7.0	7.7
	70.7	78.2
Behavioral and Neural Sciences		
Anthropology	8.4	8.9
Language, Cognition, and Social Behavior	10.1	11.2
Biological Basis of Behavior	12.7	13.7
Neuroscience	16.8	17.8
	47.7	51.6
Science and Technology Centers		
S&T Centers	9.4	10.5

Department of Energy

DOE's Biological and Environmental Research (BER) program took a substantial cut in the budget plan. Only $312 million is allocated for BER this year, down 26 percent from last year's budget of $392 million. Included in BER are several areas of research:

- Environmental research ($36.9), including marine and terrestrial research activities;
- Health effects research ($36.6) investigating the health impact of radiation and energy-related chemical exposure;
- Medical applications studies ($33.9) to develop advanced techniques for the application of radiation and radionuclides for diagnosis and therapy.
- Global change research ($77 million) to elucidate the sources and sinks in the global carbon cycle and to determine the linkage between greenhouse gases and global warming, and to quantify its effect on human and natural resources; and
- General life sciences research ($90.9) involving fundamental cellular and molecular level studies, including human genome research.

NASA

In NASA's Space Science and Applications program, the Life Sciences division received a 33 percent increase to $184 million. Within this division is a $15 million proposal to initiate the Lifesat program. Lifesat is a series of reusable satellites designed to carry living specimens into orbit, to monitor and study critical parameters such as radiation exposure, and to return the living specimens to Earth for analysis. The first launch is planned for 1996. Other research will examine the effects of long-term exposure to weightlessness and the development of biological flight experiments for use on the space station and space shuttle.

NASA's participation in the global climate change program, the largest financial commitment of any federal entity, is primarily focused on space-based studies of Earth. Nearly two-thirds of the $1.2 billion global change research budget goes to NASA.

National Oceanic and Atmospheric Administration

NOAA's Observation and Assessment program within the National Ocean Service, which provides for the management of ocean and coastal resources, will see its coastal ocean science funds increase 36 percent to $67.8 million. Much of this increase ($7 million) will focus on studies of the coastal ocean zones. Another $4.5 million will allow continued assessment of the Exxon Valdez oil spill, an increase of $2.5 million.

The budget for the National Marine Fisheries Service (NMFS), which provides for the management and conservation of living marine resources and their environment, is down by over $26 million to $175 million. Under NMFS' Information Collection and Analysis program, protected species research, including marine mammals and endangered species, was cut $645,000 to $2.2 million. NMFS' Conservation and Management Operations program received $1.5 million to establish a marine mammal tissue bank and stranding network.

NOAA's Oceanic and Atmospheric Research program is reduced $21 million despite a $31 million increase in its global climate change research. Most of the cuts come from the Ocean and Great Lakes programs.

National Institutes of Health

Of NIH's total $8.8 billion budget request, $5 billion is for basic biomedical research. Included in this amount is $851 million for HIV/AIDS research, $47 million over the previous year. Other research priorities include Alzheimer's disease ($209 million) and mapping the human genome ($110 million). DOE would receive $59 million for human genome research.

The NIH budget proposes to fund 5785 new and competing research project grants, the same number as last year. In addition, $315 million is proposed to support 12,318 research trainees, 140 more awards than last year. Stipends would increase 4 percent.

US Department of Agriculture

Agricultural Research Service

Funding for ARS, which conducts basic and applied agricultural research at federal laboratories, is scheduled to increase 6.5 percent to total $644.8 million. The increase focuses on research to promote environmentally sensitive agriculture and on interagency initiatives in water quality research and global change research. Other broad areas of emphasis include efficient food and fiber production, groundwater and other natural resources concerns, and food safety.

Cooperative State Research Service

Despite a proposed 71 percent increase in the National Research Initiative (NRI), total CSRS funded programs are down 10 percent to $409.2 million. Most of the decrease comes from the Special Research Grants program, which is cut from $62 million to $27 million.

The NRI, which sponsors research through the competitive grants process, increased from $73 million to $125 million in the president's budget. An additional $25 million is requested for a new program of university research facility competitive grants. Full matching of federal grants with nonfederal funds will be required.

Programs areas within the NRI include:

- Natural Resources and the Environment ($23 million): Research on interagency initiatives such as water quality and global change are included in this category;

- Nutrition, Food Quality and Health ($14 million): Includes research on microbiological contamination and human nutrition at the molecular and cellular levels;

- Plant Systems ($53 million): Includes $18 million to map the genomes of important crop plants; and

- Animal systems ($30 million): Research will focus on genome mapping and genetic engineering to understand the mechanisms that control fat deposition, animal disease, and reproduction.

Forest Service

USDA's Forest Service total research budget decreases by 3 percent to $163 million. Forest protection research, which studies the effects of forest fires, atmospheric factors, insects, and disease on forest and range ecosystems, is cut 8 percent to $40.3 million. Forest environmental research is down 13 percent to $37 million.

The Forest Service is also involved in the global climate change research. Funding for the Service's participation in the interagency program is up $2.8 million to $25.4 million; its research will emphasize forest ecosystem dynamics with special emphasis on carbon cycle relationships. Finally, tropical forestry research is up 70 percent to $6.3 million.

US DEPARTMENT OF AGRICULTURE

	1991 Estimate (millions)	1992 Budget (millions)
ARS Operations		
Soil and Water Conservation	$ 83.4	$ 95.4
Plant Science	232.9	243.6
Animal Science	110.0	114.2
Commodity Conversion and Delivery	118.3	129.7
Human Nutrition	49.6	50.0
Integration of Systems	11.5	11.9
Total, ARS Operations	605.7	644.8
CSRS Operations		
Hatch Act	162.3	168.3
Cooperative Forestry Research	17.8	13.0
1890 Colleges	26.3	27.3
Special Research Grants	62.4	26.7
National Research Initiative	73.0	125.0
Other	112.4	48.9
Total, CSRS Operations	454.2	409.2

Chapter 18

Chemistry in the FY 1992 Budget

American Chemical Society

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Overview

Chemistry as identified from information on agency budgets and programs encompasses a broad range of life, environmental, and physical sciences disciplines. The research supported ranges from basic through applied work to advance a mission, to routine application of known chemical principles and techniques.

A look at the proposed funding for chemistry across five agencies indicates that despite a presidential emphasis on support for the individual investigator, chemistry receives uneven treatment. Although chemistry is predicted to grow in areas tied to multidisciplinary research such as materials and the environment, support for chemistry will probably decline in real terms for FY 1992.

- At NSF, programs involving chemistry increase 10.5 percent. The principal funder--the Chemistry Division--is slated to increase 9.7 percent.
- Opportunities for chemistry at NIH are projected to increase; however, recent history indicates that this will not entirely translate into increased funding for chemists.
- Extramural support for chemistry at DOD rises only 1.4 percent.
- DOE-wide support for chemistry declines 1.3 percent; whereas chemistry within Basic Energy Sciences increases 1.3 percent.

Table I. Programs Supporting Chemistry at the National Science Foundation
(budget authority in thousands)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Request	% Change FY 91/92
Chemistry				
Analytical & Surface	$12,930	$13,660	$15,420	12.9%
Inorganic, Bioinorganic & Organometallic	$16,210	$17,310	$19,630	13.4%
Organic & Macromolecular	$24,500	$25,320	$27,670	9.3%
Physical Chemistry	$29,030	$30,060	$33,030	9.9%
Special Projects	$7,140	$7,650	$8,150	6.5%
Chemical Instrumentation	$8,110	$8,100	$8,100	0.0%
Other Directorates				
Molecular Biochemistry	$14,290	$14,600	$16,100	10.3%
Molecular Biophysics	$14,130	$15,450	$17,090	10.6%
Atmospheric Chemistry	$10,000	$12,000	$13,400	11.7%
NCAR Atmospheric Chemistry	$4,260	$4,260	$5,200	22.1%
Chemical Oceanography	$15,080	$15,890	$17,200*	8.2%
Subtotal, Programs Supporting Chemistry	$155,680	$164,300	$180,990	10.2%

Table I. Continued.

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Request	% Change FY 91/92
Materials Research				
Materials Research Project Support	$66,230	$69,630	$80,230	15.2%
Materials Research Laboratories and Groups	$34,590	$35,800	$37,800	5.6%
National Facilities and Instrumentation	$16,190	$17,150	$18,550	8.2%
Other Directorates				
Geochemistry	$14,500	$15,400	$16,300*	5.8%
Subtotal, Programs Involving Some Chemistry	$131,510	$137,980	$152,880	10.8%
TOTAL, ALL PROGRAMS INVOLVING CHEMISTRY**	$287,190	$302,280	$333,870	10.5%

* Estimate.

** Funds for Science and Technology Centers are not included.

Source: National Science Foundation

- At EPA, extramural research involving some chemistry is expected to rise 23.9 percent in FY 1992.

National Science Foundation

Programs supporting chemistry at the National Science Foundation rise 10.5 percent overall, while programs in the Chemistry Division increase 9.7 percent from FY 1991. The Division's FY 1992 request emphasizes enhanced support for individual investigators and human resources. These initiatives reflect Foundation-wide priorities.

- Support for individual investigators would rise $5.9 million over FY 1991, to be spread across the Chemistry Division's programs. Compared to the current FY 1991 funding level, two programs within the Division stand to grow the most in percentage terms: Analytical and Surface Chemistry, 12.9 percent (+$1.8 million), and Inorganic, Bioinorganic, and Organometallic Chemistry, 13.4 percent (+$2.3 million).

- While the Division's Chemical Instrumentation program remains level at $8.1 million, funds for specialized instrumentation grants would be created through a proposed $50 million Foundation-wide initiative aimed at providing grants to researchers in the $100,000 to $2 million range for equipment that is not currently funded out of existing NSF programs. Cost-sharing of at least 50 percent from non-federal sources is required.

- Funds for the Special Projects Office grow $0.5 million, or 7 percent, over FY 1991. Human resource development programs receive the bulk of the increase, with special emphasis on the Research Experiences for Undergraduates program.

Programs supported through the Materials Research Division are slated to rise 11.4 percent to $136.6 million. The Division heads the Foundation's initiative in Materials Synthesis and Processing, totalling roughly $84 million, and will work with other NSF units, including the Chemistry Division. The Chemistry and Materials Research divisions would receive $11.5 million for this initiative.

- Support for individual investigators is slated to receive an increase of $10.6 million in the Materials Research Project Support activity. Of that amount, $1 million would be directed to support high temperature superconductivity research, for a total program of $15.4 million.

- One additional Materials Research Laboratory would be established in FY 1992, for a total of 10, as well as one additional Materials Research Group, for a total of 17 groups.

Funds for seven Science and Technology Centers supported by the Chemistry and Materials Research divisions total approximately $14.7 million in FY 1991. While no new centers will be awarded in FY 1992, the total program increase of $12 million will provide full funding for those centers awarded in FY 1991, which initially received only partial funding.

Within Geosciences, funding for the Global Change program would rise $18.2 million, with emphasis on modeling the Earth's climate system, ocean circulation and ocean-atmosphere coupling, atmospheric chemistry and biogeochemical cycles, hydrologic system studies, and examination of Arctic systems.

- Atmospheric Sciences Project Support increases $10 million, or 16.8 percent, in support of the Global Tropospheric Chemistry program, the Tropical Ocean/Global Atmosphere program, and studies of global energetics and dynamics.

- National Center for Atmospheric Research funding would grow by $4.5 million in support of the Global Change program.

National Institutes of Health

Funding for conduct of R&D at the National Institutes of Health is proposed to increase 7 percent over the FY 1991 level to $8.3 billion, which represents 1.2 percent real growth over the Biomedical Research and Development Price Index of 5.8 percent. Within the request, research project grant (RPG) funding is targeted for 8.8 percent growth to $4.9 billion, with competing grant funding increasing 6.2 percent to $1.3 billion.

NIH support of chemists (excluding biochemists) is primarily through the R01 individual investigator mechanism which is part of the RPG category. RPG awards would increase to an all-time high of 21,818. However, the increase is intended to cover commitments from previous years, and the number of competing grants is slated to remain at the FY 1991 level of 5,785 awards.

Since no program within the NIH solely supports basic chemical research, opportunities for chemists must be gauged by following trends within institutes that have traditionally supported chemistry. By far the greatest support comes from the National Institute of General Medical Sciences (NIGMS), which has been slated for an R&D support increase of 10.5 percent to $738.3 million. Within NIGMS, the Cellular and Molecular Basis of Diseases program, which contains considerable opportunities in protein chemistry, would receive a 9.1 percent increase to $233.7 million. The Biophysics and Physiological Sciences program, which funds a large number of grants to academic chemistry departments, is slated to rise 9.7 percent to $171.6 million. The Pharmacological Sciences program is scheduled to increase 7.2 percent to $114 million. Basic chemistry in support of AIDS-related studies, as well as considerable efforts in chemical synthesis are funded by this last program.

The second largest supporter of chemistry at NIH, the National Cancer Institute (NCI), includes considerable support for drug development. This institute is slated to increase only 6 percent above FY 1991 to $1.8 billion for the conduct of R&D. Within NCI, the Chemical and Physical Carcinogens program will continue to focus part of its attention on activation of oncogenes by chemical carcinogens, and the relationship between heterocyclic amines and cancer. This program is slated to increase 9.3 percent to $205.9 million.

Other Institutes providing considerable support for chemistry increase their commitment to the conduct of R&D in FY 1992 (see Part II, Agency Table II-9): Heart, Lung, and Blood; Diabetes and Digestive and Kidney Diseases; and Allergy and Infectious Diseases (NIAID).

- Within NIAID, part of the 5.9 percent increase for AIDS programs (budgeted for $459.3 million) will fund antiviral, chemical synthesis projects.

- The 8.8 percent decline to $303.2 million in funding for the conduct of R&D at the National Center for Research Resources may have a negative affect on NIH support for chemists.

Department of Defense

Overall support for basic research ("6.1" category) decreases 10.3 percent to $1.0 billion in the proposed budget for the Department of Defense's Research, Development, Test, and Evaluation account. At the same time, extramural support for basic chemistry research from core programs in the DOD contract offices would increase 1.4 percent to $35.6 million.

Additional funding for basic research in chemistry comes each year from other programs in the contract offices, as well as from other DOD accounts such as the University Research initiative, In-house Laboratories, the Strategic Defense Initiative, and the Defense Advanced Research Projects Agency.

For FY 1992, the Air Force plans to emphasize multifunctional materials, carbon-carbon composites processing, and biomimetic substances; the Navy--biomimetic catalysts, and chemical aspects of the design of composites and of atomic layer epitaxy; and the Army--energetic materials, supercritical fluid media, and the destruction of toxic materials.

Table II. Core Program Support for Extramural Chemistry at Department of Defense
(budget authority in millions)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Request	% Change FY 91/92
Army	$5.1	$4.5	$4.6*	2.2%
Navy	$16.6	$15.7	$16.0*	1.9%
Air Force	$14.8	$14.9	$15.0	0.7%
Total, Programs Funding Chemistry	$36.5	$35.1	$35.6	1.4%

* Estimate.
Source: DOD Contract Offices

Department of Energy

While the posture statement for the Department of Energy emphasizes maintaining science and technology preeminence as a key to U.S. competitiveness, the real growth seen in the proposed FY 1992 DOE "science" budget is mostly for large projects and government-wide initiatives. Scheduled to receive healthy increases are the Superconducting Super Collider, up 119.8 percent to $533.7 million (including equipment and construction); the Human Genome program, up 24.5 percent to $56.8 million; Global Change - Carbon Dioxide Research, up 13.7 percent to $74.5 million; and Applied Mathematical Sciences, a 43.3 percent increase of $22.7 million entirely for the High Performance Computing and Communications initiative. In contrast, DOE programs supporting some chemistry (see Table III) decline 1.3 percent from the FY 1991 level to $239.6 million.

Basic Energy Sciences (BES) programs supporting chemistry also increase less than inflation, up 1.3 percent to $148.8 million from the FY 1991 level. Within BES, Materials Sciences and Chemical Sciences look like they have beat inflation. Yet any research pursued in new areas would have to come at the expense of existing projects. However, due to reduced taxes for designated activities in Chemical Sciences, funds could be available to cover cost-of-living expenses for research projects.

- Chemical Sciences Research declines 1.5 percent to $98 million, and the 3.9 percent increase for Chemical Facilities Operations continues the FY 1991 level of support.

- The Research component of the Materials Sciences budget decreases 4.6 percent to $133.1 million, and the Chemical Facilities Operations component increases 7.2 percent to $56.6 million. These numbers do not include support for new facilities--the Advanced Neutron Source ($23.6 million in FY 1992 Research) and the two synchrotron light sources ($43.8 million in Facilities). These amounts do not include FY 1991 funds for congressionally mandated projects.

Funding for chemistry within Biological and Environmental Research (BER), including a recently initiated university grants program in atmospheric chemistry, remains at the current level. Programs under BER and BES

Table III. Programs Supporting Chemistry at the Department of Energy
(budget authority in thousands)

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Request	% Change FY 91/92
BASIC ENERGY SCIENCES (BES) PROGRAMS				
Chemical Sciences Research*	$95,317	$99,525	$98,000	-1.5%
Materials Chemistry Research	$18,530	$19,500	$19,876	1.9%
Energy Biosciences Research	$20,389	$22,075	$24,700	11.9%
Geochemistry Research	$5,900	$5,800	$6,200**	6.9%
Subtotal	$140,136	$146,900	$148,776	1.3%
OTHER PROGRAMS***				
Biofuels Energy Systems	$6,294	$16,080	$22,200	38.1%
Biological and Environmental Research	$23,630	$20,000	$20,000**	0.0%
Conservation	$13,394	$15,021	$13,350	-11.1%
Electric Energy Systems	$8,980	$12,412	$16,900	36.2%
Fossil Energy - Chemistry	$24,950	$27,520	$13,350**	-51.5%
University Research Instrumentation	$4,869	$4,895	$4,998	2.1%
TOTAL, ALL PROGRAMS INVOLVING SOME CHEMISTRY - OPERATING EXPENSES	$222,253	$242,828	$239,574	-1.3%

* Includes atomic physics and chemical engineering.
** Estimate.
*** Includes subelements funding some chemistry.
Source: Department of Energy

will fund basic research projects in support of Environmental Restoration and Waste Management without new dollars.

Overall, the total of other programs at DOE supporting chemistry declines 5.7 percent from the FY 1991 level, primarily due to the 51.5 percent drop in chemistry under Fossil Energy R&D. Much of this chemistry is funded out of the program elements for advanced coal research and technology development (ARTD), which is pared back to $39.8 million, a decline of 18.8 percent from the congressional appropriation for FY 1991. Under the main ARTD program, University Coal Research decreases 4.9 percent to $5 million. This decline is due to the breaking out of $2.5 million in support as a separate line item for research in coal, oil, and gas at historically black colleges and universities, as well as for summer faculty and student intern positions for women and minorities at DOE facilities. The latter focus is part of a multi-agency emphasis on education and human resources.

Environmental Protection Agency

The ultimate purpose of Environmental Protection Agency's research program is to support the agency's regulation of air and water quality, hazardous waste management, pesticides, toxic substances, and radiation. Although the overall FY 1992 budget request for EPA R&D is 13.3 percent above the FY 1991 appropriation (excluding funds for R&D facilities), it is unclear whether the increase is sufficient to meet the growing demand for accurate information concerning the effects of environmental problems and their associated risks.

Owing to the regulatory nature of EPA's mission, almost all R&D activities entail some form of chemical support. Since EPA funding is divided by program function rather than by discipline, this report discusses only those functions that appear to contain some chemical sciences activities.

- Funds for Monitoring, Characterization, and Quality Assurance activities would rise $38.8 million, an increase of 83.1 percent. New studies supporting the 1990 Clean Air Act are slated to rise $35.1 million, in part to support work on the formation and deposition of ozone and acid

Table IV. Programs Supporting Some Chemistry at the Environmental Protection Agency (budget authority in thousands)

		FY 1990 Actual	FY 1991 Estimate	FY 1992 Request	% Change FY 91/92
Monit. Systems, Charac., & Qual. Assurance:	In-house	$17,665	$15,625	$23,317	49.2%
	Extramural	$29,085	$31,032	$62,123	100.2%
Subtotal		$46,751	$46,657	$85,440	83.1%
Health Effects:	In-house	$16,876	$15,265	$14,114	-7.5%
	Extramural	$30,352	$26,369	$29,199	10.7%
Subtotal		$47,228	$41,633	$43,313	4.0%
Environmental Engineering & Technology:	In-house	$16,387	$15,540	$16,594	6.8%
	Extramural	$72,903	$61,923	$57,828	-6.6%
Subtotal		$89,289	$77,463	$74,422	-3.9%
Environmental Processes & Effects:	In-house	$24,325	$24,025	$24,651	2.6%
	Extramural	$25,574	$27,682	$35,985	30.0%
Subtotal		$49,899	$51,707	$60,636	17.3%
Intermedia Research:	In-house	$11,584	$12,806	$14,680	14.6%
	Extramural	$71,933	$110,372	$136,007	23.2%
Subtotal		$83,517	$123,178	$150,686	22.3%
Acid Rain:	In-house	$2,025	$742	$761	2.7%
	Extramural	$27,779	$9,392	$9,392	0.0%
Subtotal		$29,804	$10,134	$10,154	0.2%
ALL PROGRAMS INVOLVING SOME CHEMISTRY	In-house	$88,862	$84,002	$94,117	12.0%
	Extramural	$257,626	$266,770	$330,534	23.9%
	TOTAL	$346,488	$350,772	$424,651	21.1%

Source: Environmental Protection Agency

aerosols. Studies of the effects of agricultural pesticides on surface and groundwater hydrological systems would grow $1 million.

- Health Effects programs are expected to increase $1.7 million, up 4 percent. Among other things, funds would support the development of drinking water contaminant level standards, and the evaluation of chemical mixtures at Superfund sites.

- Environmental Engineering and Technology activities would decrease $3 million, or 3.9 percent, to $74.4 million. Studies on various techniques for the removal of pesticides from drinking water would grow $0.3 million. Funds for prediction of releases of toxics from the manufacture and processing of new chemicals would rise $0.7 million. Decreases are found in air, radiation, and drinking water programs.

- Activities under the Environmental Processes and Effects category would grow $8.9 million, up 17.3 percent. Studies examine the effects of tropospheric ozone on forest systems, wellhead protection, and the development of pollution-specific treatment technologies. Studies on the impact of existing chemicals on fresh- and saltwater aquatic life would be funded at $0.2 million.

- The Intermedia Research function would grow $27.5 million, or 22.3 percent, to support lead abatement research, and the development of neurotoxicity guidelines, as well as technology transfer and educational activities at EPA's labs.

- EPA's Acid Rain program would rise 0.2 percent, up $0.02 million, primarily in support of ongoing monitoring of acid deposition, and the statistical analysis of source/receptor relationships.

Chapter 19

Behavioral and Social Research in the FY 1992 Budget

Federation of Behavioral, Psychological & Cognitive Sciences, Claudia Feller

American Psychological Association, Barbara J. Calkins

American Educational Research Association, Marcia Knutson

It is well documented that federal funding for research in the behavioral and social sciences has fluctuated markedly in recent decades. While federal support for most scientific research has increased substantially and with predictable regularity, overall funding for the behavioral and social sciences has fallen. Highlights of the FY 1992 budget proposal for relevant programs are represented in Tables 1-3, and brief analyses of certain programs follow.

Department of Health and Human Services (HHS)

The Administration's FY 1992 budget for HHS reflects the conviction of Secretary of Health and Human Services Louis H. Sullivan, M.D., that behavior change--the hallmark of the behavioral and social sciences--is the key to prevention and better health for all Americans. "Focusing on Prevention and the Next Generation" is a theme and priority of the Bush budget.

The rewards of past federal investment in behavioral research are highlighted in the President's budget, which states: "The nation has witnessed the effects of changes in behavior across society as the incidence of one of the leading contributors to preventable deaths, smoking, has declined in adults from 40 percent in 1965 to 28 percent in 1990...The favorable effects of these and other behavior changes have been enormous." The Administration's budget reflects a new priority on the relationship between health and human behavior, opening the door to increased scientific inquiry in this area.

For the National Institutes of Health (NIH), the Administration requests an overall increase of 8.8 percent in the research projects line, or $4.9 billion of the total $8.8 billion request for NIH. Most of NIH's research institutes support or conduct behavioral research, exploring behavioral and social factors in health promotion, disease prevention, treatment, and child development and aging processes.

The congressionally mandated plan for proportionally increasing health and behavior research funding by NIH is due to be finalized soon. The most recent data available (FY 1989) show that NIH funded an estimated $258 million in health and behavior research, according to NIH's new and more inclusive measurement method. This more generous analysis brings health and behavior as a percent of the NIH FY 1989 overall $8.3 billion budget up to 4.3 percent. FY 1992 funding proposals for the programs that include this research vary broadly.

The National Institute of Mental Health (NIMH), housed along with the National Institute on Drug Abuse (NIDA) and the National Institute on Alcohol Abuse and Alcoholism (NIAAA), under the aegis of the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), provides the lion's share of funding for behavioral research on mental health and disability.

Although the Administration's budget proposes a 7.6 percent increase in funding for NIMH's research activities, there would be fewer new and competing grants than in FY 1991 (343 compared to 402), and the overall award rate for competing grants would decrease from 28 percent to 22 percent. There would also be fewer new and competing grants at NIDA, where only 194 could be funded compared with 251 in FY 1991. Increased support for medications development is proposed at both NIMH and NIDA.

The Agency for Health Care Policy and Research (AHCPR) is responsible for research on medical treatment effectiveness, patient outcomes, and improvements in health care delivery methods. The figures in Table 1 represent AHCPR budget authority, plus funds available to the program through 1 percent PHS evaluation funds and the Medicare Trust Funds.

Table 1. Department of Health & Human Services
(budget authority in millions)

	FY 1990 actual	FY 1991 estimate	FY 1992 budget	% change FY 1991-92
ALCOHOL, DRUG ABUSE & MENTAL HEALTH ADMINISTRATION				
Mental Health				
Extramural Research	$543.5	$589.7	$615.7	4.4
Drug Abuse				
Extramural Research	397.7	416.0	446.2	7.3
Alcohol Abuse				
Extramural Research	162.2	171.2	166.8	-2.6
Treatment Outcome Research	7.8	8.1	8.6	6.2
Substance Abuse Prevention	193.4	271.5	281.6	3.7
NATIONAL INSTITUTES OF HEALTH				
Cancer				
Cancer Prevention & Control	80.5	90.9	96.0	5.6
Heart, Lung & Blood				
Heart & Vascular Diseases	579.6	589.0	631.8	7.3
Dental				
Disorders of Structure, Behavior	26.5	29.3	31.7	8.2
Diabetes, Digestive & Kidney Disease				
Digestive Disease & Nutrition	119.8	121.6	130.0	6.9
Neurological Disorders & Stroke				
Biological Basis Research	261.2	280.1	286.8	2.4
Clinical Research	142.3	164.7	189.1	15.3

Table 1. (continued) Department of Health & Human Services
(budget authority in millions)

	FY 1990 actual	FY 1991 estimate	FY 1992 budget	% change FY 1991-92
Child Health & Human Development				
Research for Mothers & Children	245.0	262.9	281.7	7.1
Population	119.0	129.6	138.9	7.2
Medical Rehabilitation Research	---	---	3.8	---
Eye				
Strabismus, Amblyopia & Visual Processing	42.3	44.0	47.1	7.0
Environmental Health				
Applied Toxicological Research	56.6	60.7	62.2	2.5
Aging				
Aging Research	195.9	272.0	293.0	7.7
Deafness & Communication Disorders				
Research	107.1	122.8	132.9	8.2
Nat'l Center for Nursing Research	30.5	35.7	39.2	9.8
AIDS RESEARCH & PREVENTION				
Public Health Service	1,590.0	1,885.0	1,950.0	3.4
ADAMHA	215.0	237.0	245.0	3.4
NIH	744.0	804.0	851.0	5.8
Centers for Disease Control	443.0	495.0	495.0	0
AGENCY FOR HEALTH CARE POLICY & RESEARCH				
Health Services Research	51.0	42.0	48.0	4.3
Medical Treatment Effectiveness	38.0	63.0	63.0	0

National Science Foundation (NSF)

Perhaps the best FY 1992 budget news for scientists is the proposed NSF budget (+18 percent), but the news is better for some scientists than others. Proposed increases for the six research directorates range from 23 to 13 percent--the lowest being for the Biological, Behavioral and Social Sciences (BBS). Proposed increases for the six BBS divisions range from 21 to 8 percent--the lowest being for the Behavioral and Neural Sciences (BNS).

A new initiative in cognitive science would support workshops and seminars on planning, coordinating and implementing a study of intelligent systems. BBS would also establish a research and training center for survey methods. In addition, support for both economics and the human dimensions of global environmental change would be significantly enlarged:

- Increased recognition of the role that economics plays in global change prediction and assessment is reflected in a substantial increase in the scope and funding of the economics research effort in the FY 1992 U.S. Global Change Research Programs. The President's FY 1992 budget proposes $17.5 million for global change economics research among seven agencies--an increase of $9.3 million over FY 1991 enacted funding levels. The NSF grants program in Global Change Economics would be increased from $1.2 million in FY 1991 to $3.4 million in FY 1992.

- Without an understanding of human interactions in global environmental change that is based both on empirical observations of human behavior and on a better understanding of the consequences of human actions, the models of physical and biological processes of change will be incomplete. Such links to human behavior are required for fully effective national and international policies to deal with global change. The Human Dimensions of Global Environmental Change program at BBS would be increased from $2.4 million in FY 1991 to $3.4 million in FY 1992.

NSF budget proposal details of interest to behavioral and social scientists are found primarily in this chapter's Table 2. Information on NSF's Education and Human Resources Directorate, however, is included in Table 3.

Table 2. National Science Foundation
(budget authority in millions)

	FY 1990 actual	FY 1991 estimate	FY 1992 budget	% change FY 1991-92
BIOLOGICAL, BEHAVIORAL & SOCIAL SCIENCES				
Behavioral & Neural Sciences				
Anthropology	$ 8.0	$ 8.4	$ 8.9	6.8
Language, Cognition & Social Behavior	9.6	10.1	11.2	11.2
Biological Basis of Behavior	12.0	12.7	13.7	8.2
Neuroscience	16.2	16.8	17.8	6.2
Social & Economic Sciences				
Economics	13.3	14.6	17.9	22.3
Geography	3.2	3.5	4.1	16.6
Sociology	4.0	4.2	4.9	16.1
Measurement Methods & Data Improvement	2.4	2.5	2.8	13.1
Political Science	3.9	4.2	4.9	16.4
Law & Social Sciences	2.1	2.3	2.6	13.4
Decision, Risk & Management Science	3.4	3.7	4.1	12.5
Instrumentation & Resources				
Instrumentation & Instrumentation Development	16.0	15.4	16.0	3.9
Special Projects	19.9	21.7	29.0	33.7
Studies in Science & Technology	2.4	3.1	3.5	14.4
COMPUTER & INFORMATION SCIENCE & ENGINEERING				
Information, Robotics & Intelligent Systems				
Knowledge & Database Systems	7.8	9.1	11.6	27.6
Robotics & Machine Intelligence	6.2	6.5	7.8	18.9
Interactive Systems	2.6	3.0	4.0	31.8
Information Technology & Organizations	3.3	4.1	5.3	28.4

Department of Education

The Administration's budget request for the Department of Education reflects an overall increase of $2.5 billion. However, the net increase for currently authorized discretionary education programs is only $63 million, an increase of less than 1 percent. The remainder of the increase would fund the Administration's proposed "Education Excellence Act," as well as mandatory accounting changes in the Guaranteed Student Loan program.

Generally accepted as a federal education role, research programs (including statistics and assessment) within the Office of Educational Research and Improvement (OERI) will see substantial increases. Primary obligations of the research portion of the account are: 25 national education research centers for which $26.1 million has been requested for FY 1992, an increase of 18.7 percent; 10 regional education research labs for which the request is $30.9 million, a 24.4 percent increase; and the Educational Resources Information Centers (ERIC) system, which received a 7 percent increase to $7.2 million. The budget doubles field-initiated studies, from $0.976 million to $2 million.

The collection, analysis and reporting of statistical data at the Department of Education is carried out under the direction of the National Center for Education Statistics (NCES). Funding for NCES has increased from $8.9 million in FY 1987 to over $44 million in FY 1991. The request for FY 1992 is almost $52 million, 17.3 percent over FY 1991. A large portion of the increase will fund various post-secondary surveys and international comparisons.

The National Assessment of Educational Progress (NAEP) surveys achievement by subject and grade level. NAEP disseminates its information through public reports designed to help educators and policymakers improve education. NAEP funding nearly quadrupled from 1987 through 1991, and the FY 1992 request is a 46.2 percent increase over last year.

Numerous small demonstration and improvement programs previously financed in the School Improvement Account are now included in the OERI budget, most are proposed for level or reduced funding. The notable exception is the Eisenhower Math and Science Education National Programs account, for which a 25.6 percent increase is requested. See Table 3 for educational R&D at OERI as well as NSF.

Table 3. Educational Research & Development
(budget authority in millions)

	FY 1990 actual	FY 1991 estimate	FY 1992 budget	% change FY 1991-92
DEPARTMENT OF EDUCATION - OERI	$179.6	$228.5	$260.8	14.1
Research	55.5	64.7	74.3	14.8
Statistics	22.7	44.3	52.0	17.3
Assessment	17.1	19.2	28.1	46.2
Fund for Innovation in Education	18.9	27.7	27.7	0
FIRST	8.4	8.9	2.8	-68.4
Eisenhower Math & Sci Ed Nat'l Progs	8.8	11.7	14.7	25.6
National Diffusion Network	12.8	14.2	14.2	0
Blue Ribbon Schools	0.5	0.9	0.9	0
Javits Gifted & Talented Students Ed	9.9	9.7	9.7	0
Star Schools	14.8	14.4	10.0	-30.6
Educational Partnerships	3.7	4.2	4.2	0
Territorial Teacher Training	1.8	1.8	1.8	0
LEAD	3.8	3.8	0.4	-90.3
Midcareer Teacher Training	1.0	1.0	0	-100.0
Partnerships for Innovative Teacher Ed*	0	0	20.0	—
Nat'l Council on Ed Goals*	0	2.0	0	-100.0
NSF - EDUCATION & HUMAN RESOURCES	220.6	322.4	390.0	21.0
Research Career Development	36.8	47.9	61.0	27.3
Materials Dev, Res & Informal Sci Ed	48.2	66.0	82.0	24.2
Teacher Preparation & Enhancement	81.0	118.6	139.0	17.2
Studies, Eval & Dissemination	4.3	9.0	11.0	22.2
Undergrad Sci, Engr & Math Ed	22.7	41.0	47.0	14.6
Human Resource Development	27.6	39.9	50.0	25.5

* not authorized

Department of Defense (DOD)

DOD is a major supporter of behavioral and social science research; most is categorized as "human resources technologies"--manpower, personnel, training and human factors in systems. Increasingly, the emphasis is on the immediate questions and needs of the services. This research, like all Defense R&D, is classified by type of effort (6.1, basic research; 6.2, exploratory development; 6.3, advanced development; and 6.4, prototype development). Most university-based behavioral scientists are interested in 6.1 and 6.2.

FY 1992 funding for the Air Force Office of Scientific Research (AFOSR) would be $203.2 million, up from the FY 1991 actual of $187.6 million. Funding for AFOSR's Life Sciences Directorate would also go up--from the FY 1991 actual of $18.6 million to the FY 1992 request of $23.3 million.

At the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), the budget for 6.1, 6.2 and 6.3A (nonsystem advanced development) would go down from the $38.52 million received in FY 1991 to $37.8 million for FY 1992. However, funding in ARI's Office of Basic Research would increase--from the $3.3 million received in FY 1991 to the $3.7 million requested for FY 1992.

Meanwhile, back at the Navy, the Office of Naval Research (ONR) Cognitive and Neural Sciences Division (6.1) would go from $13.9 million in FY 1991 funds to an estimated $14.1 million in FY 1992 under the current proposal.

Other Programs

The Department of Agriculture's Agricultural Research Service, Cooperative State Research Service, Economic Research Service, and Forest Service all fund some behavioral and social science research; however, they are covered in other chapters and tables in this volume.

USDA's Agricultural Cooperative Service (ACS) helps farmers help themselves by providing the assistance necessary to support and improve existing cooperatives and organize new cooperatives. ACS provides technical assistance and conducts research on economic, financial, organizational, legal, social, and other related issues that affect cooperatives. The FY 1992 budget requests $5.1 million for ACS, an increase of $0.2 million.

USDA's Human Nutrition Information Service (HNIS) conducts applied research in food and nutrition. The FY 1992 budget requests $12.7 million, up $2.8 million from the FY 1991 current estimate of $9.9 million, to:

- Fund implementation of the National Nutrition Monitoring and Related Research Act of 1990. This includes 4 staff years and $1.6 million, mostly for survey design and methodology research for new surveys.

- Provide $0.5 million to fully fund HNIS participation in the USDA Pesticide Data Program to $1.0 million. As one of the four key agencies, HNIS will continue to develop a linkage of food intake data on individuals through an expanded Food Grouping System, with pesticide residue data provided by other agencies in the program.

- Provide $0.3 million to support ongoing research and $0.4 million for pay cost increases.

USDA's National Agricultural Statistics Service (NASS) collects and reports statistical data, but also conducts and coordinates research on statistical techniques. An increase of $10.4 million over the FY 1991 current estimate of $76.7 million is requested. This increase includes $2.5 million for an expansion of the survey of pesticide use data, and $1.85 million to improve statistical sampling frames.

The Department of Commerce's Bureau of the Census has a small general research program that conducts research on survey methods and techniques to find ways of improving the efficiency, accuracy, and timeliness of statistical programs. Funding in FY 1991 is $0.749 million; the FY 1992 budget proposal for this program is $0.792 million.

The Department of Justice's Office of Justice Programs includes research, evaluation, and demonstration programs for the development of basic and applied research on the improvement of justice systems. FY 1991 funding is $25.6 million; funding proposed for FY 1991 is $23.9 million.

Chapter 20

Federal Statistics in the FY 1992 Budget

Council of Professional Associations on Federal Statistics

Katherine K. Wallman

Overview

Statistics produced by the federal government serve as a base for research in a broad spectrum of scientific disciplines. Population and vital statistics are central to the work of demographers and actuaries; employment, financial, and production data are essential for economists; and information on education and crime is used by sociologists and psychologists.

Researchers in the social sciences are not alone in their reliance on federal statistics. Epidemiologists and biostatisticians depend on data from the National Center for Health Statistics and the National Institutes of Health; meteorologists rely on information compiled by the National Oceanic and Atmospheric Administration; and scientists in an array of professions are concerned with statistics that are gathered and distributed by agencies such as the National Science Foundation, the Soil Conservation Service, the Environmental Protection Agency, and the Geological Survey.

Responsibility for the collection, analysis, and dissemination of federal statistics is spread throughout the departments and independent agencies of the executive branch; each of some 70 agencies and departmental units annually spends $500,000 or more on statistical activities. Within this decentralized system that generates statistical information, a more limited number of agencies have the creation of statistics as their principal mission. It is these agencies, which are responsible for producing statistics on major economic, demographic, and social developments and trends, that are the focus of discussion in this chapter.[1]

For FY 1992, funding levels that have been proposed for the principal statistical agencies in several cases would provide significant increases over the resources appropriated in FY 1991.[2] In particular, the Administration's proposal for FY 1992 places special emphasis on activities to strengthen economic statistics, continuing a multi-year initiative recommended by the Economic Policy Council and approved by the President. This initiative, which would provide a funding increase of more than $200 million over the five-year period 1992-1996, includes activities to modernize the National Income and Product Accounts to improve their accuracy, breadth, and international comparability; improve the coverage and detail of international flows of funds; separate quality and inflation changes in price data; and increase coverage of the service sector, which accounts for more than 70 percent of total U.S. output.

Funds also are requested in the FY 1992 National Science Foundation budget to establish a graduate program specifically designed to meet federal statistical survey needs. Creation of the proposed Center for Survey Methods would allow both current and prospective federal statisticians to undertake graduate study in survey statistics and permit others in the statistical system to upgrade their skills through relevant courses. The balance of this chapter provides further details on FY 1992 budget proposals for the principal statistical agencies.

Bureau of the Census

The Bureau of the Census collects, compiles, and publishes general purpose statistics on the population and the economy. Budget authority for the Census Bureau is provided in two appropriations: one covers "current programs," including demographic surveys, international programs, and data on construction, manufacturing, retail and wholesale trade, services, foreign trade, and state and local government finances and employment; the other covers "periodic programs," including the decennial census of population and housing, intercensal estimates of population, and the quinquennial economic censuses, census of governments, and census of agriculture.[3/] For FY 1992, the proposed $132.5 million level for the current programs budget provides an increase of $22.2 million over FY 1991, an amount that would permit the Census Bureau to continue its base programs and to implement portions of the initiative to improve economic statistics. Increases for activities to improve information on the service sector would include research and design of a program to provide corporate financial data for the business services industry; restoration of the small mining and trade companies sample and enhancement of the small company manufacturing sample for collection of financial data; expansion of the Service Annual Survey to measure changing revenue and expense components for priority service industries, and to cover additional industries; testing of instruments to gather new data on legal, accounting, and other services purchased by industry; and research and design of studies to identify and improve understanding of emerging industries. Other increases related to the initiative to improve economic statistics include funding for research on the Standard Industrial Classification structure; activities to improve export reporting; correction of deficiencies in construction statistics; implementation of a business list sharing arrangement with the Bureau of Labor Statistics; and research to identify and measure errors affecting advance retail sales estimates.

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[1] The publication date for this report precludes completion by other agencies of the analyses required to present budget data for their "statistical" activities.

[2] For details of the funding history in fiscal years 1990 through 1992, see the table at the end of this chapter.

Bureau of Labor Statistics

The Bureau of Labor Statistics collects, analyzes, and disseminates data on employment and unemployment; prices and living conditions; consumer expenditures;

[3/] See table for information concerning the proposed FY 1992 budget for Census periodic programs. The funding request includes resources to increase planning efforts related to the year 2000 decennial census. Activities will focus on examination and testing of policy and technical issues and alternatives.

wages and employee benefits; industrial relations activities; productivity and technological change in U.S. industries; projections of economic growth, the labor force, and employment by industry and occupation; and occupational injuries and illnesses. For FY 1992, the proposed budget authority of $308.9 million, a rise of $53.7 million over the estimated level for 1991, would allow BLS to continue its highest priority programs, to undertake components of the economic statistics improvement initiative, and to extend work to meet the data requirements of the Federal Employees Pay Comparability Act of 1990. Proposed FY 1992 BLS activities related to the economic statistics initiative include improvements to: the timeliness, accuracy, and scope of the monthly employment estimates; the accuracy and coverage of the monthly measures of unemployment; the accuracy and conduct of business surveys, through expanded data coding and processing operations in the underlying BLS business establishment list; and the principal measures of inflation -- the Consumer Price Index, the Producer Price Index, and Export and Import Price Indexes -- through more timely updating of industry and product samples, improved methods of distinguishing quality change from price change, and extension of program coverage for the service sector. To address the requirements for data on pay levels for specific occupations in localities throughout the country, BLS will continue activities begun in FY 1991 to expand its wage survey program to incorporate the industrial, occupational, and geographic coverage required for administration of the new federal pay legislation. In addition to these two major areas of program expansion, the BLS budget for FY 1992 includes a planned incremental increase for the Current Population Survey redesign, and resources to cover the one-time costs associated with consolidation of BLS staff in a single building site. In order to provide resources for continuing BLS series having the highest priority, the FY 1992 budget proposes to terminate the Mass Layoff Statistics program, a federal-state cooperative effort for which BLS has provided developmental funds since 1984.

Bureau of Economic Analysis

The Bureau of Economic Analysis prepares and interprets the economic accounts of the United States. These include the national economic accounts, comprising the GNP accounts as well as wealth accounts, input-output accounts, and measures relating to environmental change; the international economic accounts, consisting of the balance of payments and associated foreign investment accounts; and the regional economic accounts, consisting of personal income measures by state and county. BEA also prepares the system of business cycle indicators, including the index of leading economic indicators. For FY 1992, BEA's proposed budget authority would rise by $7.3 million over the FY 1991 level to a total of $37.8 million, allowing the agency to undertake a number of activities related to the economic statistics improvement initiative. Increased funding for the national economic accounts would be used to stop deterioration of the present accounts and to undertake work necessary for the United States to move to a modernized and extended set of accounts in the mid-1990's. New or improved measures would be developed for consumer expenditures on services and output of service industries, prices of high-tech goods other than computers, detailed types of goods and services purchased by state and local governments, and activities of the nonprofit sector. In addition, preparation of the input-output tables would be accelerated. The set of national accounts to be introduced in the mid-1990's will be consistent with international guidelines in the upcoming revision of the United Nations' System of National Accounts, which will include full current and capital accounts and satellite accounts. Increased funding for the international economic accounts would be used to develop improved measures of flows of both portfolio and direct investment and to further improve international services data. Like the national accounts, the international accounts would be modernized and extended in order to conform to new international guidelines.

Statistics of Income, Internal Revenue Service

The IRS Statistics of Income program provides annual income, financial and tax data based on individual and corporate income tax returns; periodic studies based on returns such as those filed by tax-exempt organizations; and in-depth analyses of various tax-related computations, including those reported for the foreign tax credit and sales of capital assets. For FY 1992, a total budget authority of $24.8 million is proposed for the SOI program, an amount that exceeds the FY 1991 estimate by $1.0 million. The increase in funding represents inflation adjustments only; no major program changes are planned. Major innovations continue to be concentrated instead on a number of initiatives designed to improve data quality and realize processing efficiencies. For example, implementation of a new distributed processing system will enable IRS to deliver in FY 1992 the earlier preliminary corporation income tax return profits data required by BEA for the national accounts.

National Agricultural Statistics Service

The National Agricultural Statistics Service collects and reports data on a wide range of agricultural characteristics, including crop and livestock production, inventories, prices paid and received by farmers, costs of production, farm labor usage and wage rates, and other agricultural economic indicators. For FY 1992, the proposed budget authority for NASS is $86.9 million, an increase of $10.4 million over FY 1991. Funding at this level would allow NASS to expand collection of data on pesticide uses to provide more useful and current data in support of the Food Safety Initiative; to improve sampling frames to enhance efficiency and quality of data collection in support of the economic statistics improvement initiative; to develop and test a survey of mandatory applicator records of the utilization of restricted use pesticides; and to expand and improve data collection on fruits, vegetables, and other crops.

Economic Research Service, USDA

The Economic Research Service performs agricultural economic and other social science research, outlook forecasting, and policy analysis, and develops economic and statistical indicators related to U.S. and international agriculture, food, natural resources, and rural America. For FY 1992, a funding level of $62.5 million is proposed for ERS, an increase of $8.1 million over FY 1991. The requested increase would be applied to analysis of food safety issues, expansion of chemical data collection and water quality analysis, and study of global change issues.

Energy Information Administration

The Energy Information Administration collects, analyzes, and disseminates data on energy resources, production, distribution, consumption, technology, and related international, economic, and financial matters.

EIA produces reports with statistical time series, projections of future energy trends, and analyses of topical energy issues, and supports the information needs of the Department of Energy. EIA's proposed budget for FY 1992 is $76.5 million, an increase of $7.6 million over FY 1991. Funding at the proposed level would allow the agency to continue most of its basic programs, to expand energy consumption data bases, and to increase modeling and analytical activities. Enhancements to the EIA program would include increasing information and analysis on the demand side of the energy equation, and expanding data, modeling, and analysis of renewable energy sources, new energy-efficient technologies, and environmental impacts of energy production and consumption. To partially offset some of the increased funding requirements, EIA is proposing to reduce or eliminate some of its lower priority programs, including the Financial Reporting System and the annual uranium industry viability assessment.

National Center for Health Statistics

The National Center for Health Statistics produces information on the full spectrum of concerns in health from birth to death, including overall health status, lifestyle and exposure to unhealthful influences, the onset and diagnosis of illness and disability, and the use of health care and rehabilitation services. Data sources include the nation's vital statistics system and surveys involving personal interviews, physical examinations and laboratory testing, and information from health care providers. For FY 1992, the Administration budget proposes total funding of $85.2 million for the Center's programs, including $33.8 million to be made available for NCHS activities from Public Health Service "evaluation funds." The increase of $14.8 million in overall funding proposed for NCHS programs will allow the agency to operate its data systems at planned levels. These include the National Health Interview Survey, which would be conducted at the full sample size of 50,000 households; the periodic National Survey of Family Growth and National Mortality Followback Survey; the National Health and Nutrition Examination Survey; the National Vital Statistics System, including components measuring births, deaths, marriages, divorces, and induced terminations of pregnancy; and the National Health Care Survey. The FY 1992 request also includes funding for an effort to improve the timeliness and quality of health data through expanded use of automation and technology in various phases of NCHS data collection, processing, and dissemination.

National Center for Education Statistics

The National Center for Education Statistics collects, analyzes, and reports statistics on American education; conducts studies on international comparisons of education statistics; and provides leadership in developing and promoting the use of standardized terminology. For FY 1992, a budget authority of $80.1 million is proposed, an increase of $16.6 million over FY 1991. Of this total, $28.1 million would support the National Assessment of Educational Progress (NAEP); the balance would fund the Center's ongoing programs, as well as activities initiated pursuant to mandates of the Elementary and Secondary School Improvement Amendments of 1988 and requirements stemming from the National Education Goals. Resources for NAEP would support conduct of the 1992 assessment, which will include state-level assessments of mathematics in grades 4 and 8 and of reading in grade 4, as well as further analyses of the 1990 assessment data. For programs related to elementary and secondary education, the FY 1992 budget would support analysis and reporting of data from the Schools and Staffing Surveys; continuing efforts to improve the comprehensiveness and comparability of the Common Core of Data; continued expansion of the National Cooperative Education Statistics System, including implementation of a new dropout component and development of state-wide automated data collection systems; and data collection for the second follow-up of students in the National Education Longitudinal Study of the eighth grade class of 1988. At the postsecondary level, the proposed budget would support field tests for the 1993 National Postsecondary Student Aid Study and the National Survey of Postsecondary Faculty; data collection for two components of the Center's postsecondary longitudinal study; continuation and upgrading of the Integrated Postsecondary Education Data System; and development of methodologies for assessment of postsecondary students and for collecting data on postsecondary graduation rates. In addition, requested funding will support design of the third international mathematics and science study; continuing development and implementation of international education indicators; the conduct of a survey for the Adult Literacy Assessment; the reporting of 1990 census data by school district boundaries; and the collection of data on school, academic, and public libraries.

Bureau of Justice Statistics

The Bureau of Justice Statistics is responsible for collecting, analyzing, and disseminating information on crime, victims of crime, criminal offenders, and operations of justice systems at all levels of government. For FY 1992, the proposed budget authority is $23.2 million, an increase of $1.1 million over FY 1991. The requested funding level includes an increase to establish a comprehensive statistical series to measure intentional injuries with a focus on obtaining a measure of the incidence of family violence serious enough to result in a visit to a hospital emergency room. The proposed series would gather data through the National Electronic Injury Surveillance System which is used by the Consumer Product Safety Commission to monitor consumer product-related injuries and deaths. The proposed budget also includes an increase to reinstate the Criminal Justice Expenditure and Employment Survey, which would in addition to its other uses provide the detailed data necessary to ensure proper allocation of state and local anti-drug abuse formula grants.

Office of Policy Development and Research, HUD

The Office of Policy Development and Research at the Department of Housing and Urban Development maintains data series on national, regional and local economic and housing market conditions. These include information on the physical and financial characteristics of national and selected metropolitan housing inventories and the characteristics of occupants; housing units under construction and completed; new one-family home sales; market absorption of new rental apartments and condominiums; the placement of new mobile homes; and mortgage lending and commitment activity. For FY 1992, a funding level of $14.6 million for the housing and financial market statistical programs is proposed, an amount that will support continuation of ongoing activities including the post-censal Residential Finance and Components of Inventory Change surveys.

Principal Federal Statistical Agencies
(total direct funding in millions)

	FY 1990 Actual5/	FY 1991 Estimate	FY 1992 Budget
Bureau of the Census (current programs)1/	$ 99.9	$110.3	$132.5
Bureau of Labor Statistics	241.4	255.2	308.9
Bureau of Economic Analysis	25.6	30.5	37.8
Statistics of Income, IRS	19.9	23.8	24.8
National Agricultural Statistics Service	66.9	76.5	86.9
Economic Research Service, USDA2/	50.7	54.4	62.5
Energy Information Administration	64.3	68.9	76.5
National Center for Health Statistics3/	66.1	70.4	85.2
National Center for Education Statistics4/	39.7	63.5	80.1
Bureau of Justice Statistics4/	20.9	22.1	23.2
Policy Development and Research, HUD	12.6	14.7	14.6

Notes: 1/The proposed FY 1992 budget for periodic programs at the Bureau of the Census is $175.0 million; these funds would be used to analyze and disseminate 1990 Decennial Census data, begin planning for the year 2000 Decennial Census, and prepare for the 1992 Economic Censuses. 2/Approximately 20 percent of the Economic Research Service budget, shown here in total, is used for surveys, data collection, and preparation of statistical reports. 3/Funding levels shown for NCHS include $19.0 million in FY 1990 and FY 1991, and $33.8 million in FY 1992 from Public Health Service Evaluation Funds. 4/Funding levels shown for NCES and BJS do not include S&E from other departmental sources; for FY 1992, NCES will have an estimated $10.2 million in S&E budget, and BJS will have an estimated $3.6 million in S&E budget. 5/FY 1990 figures reflect the sequester pursuant to P.L. 99-177.

Chapter 21

Mathematical Sciences in the FY 1992 Budget

Joint Policy Board for Mathematics

Lisa Thompson

Trends in Federal Support for the Mathematical Sciences

Federal support for the mathematical sciences expanded significantly during the early and mid-1980's, and included the establishment of new mathematics programs at the Defense Advanced Research Projects Agency and the National Security Agency. Starting in about FY 1988, however, government-wide spending on mathematics reached something of a plateau, with little or no real annual growth since.

The burgeoning federal budget deficit and Gramm-Rudman-Hollings deficit caps are largely responsible for these lean years. Despite presidential proposals for healthy increases, spending plans for basic research typically suffer at the hands of the congressional budget process. Furthermore, basic research in support of defense, which accounts for more than one-third of federal support for mathematics, is declining in real terms, although Congress eased the decline in FY 1991, in part with earmarks. Budgets for the mathematical sciences are strongly correlated to the overall basic research budgets.

In the context of recommendations made by the National Research Council's Board on Mathematical Sciences, progress toward bringing federal support for mathematics into balance with support for other scientific disciplines of comparable size, while significant, falls short of demonstrated need. The rise in funding of the early and mid-1980's did contribute to much-needed growth in graduate research assistantships and postdoctoral fellowships.

On the brighter side, several multiagency research initiatives of national interest will provide new opportunities for the mathematical sciences. The High Performance Computing and Communications program is designed to extend U.S. leadership in all advanced areas of computing and networking and includes as a component expanding basic research and human resources in this field. The mathematics programs at the National Science Foundation and Department of Energy are involved in this initiative. The mathematics division at NSF has also begun a program to foster collaboration between mathematicians and geoscientists, as part of a government-wide focus on global change research. It is possible that for the immediate future such national initiatives in support of specific goals will be the only significant source of new funds for basic research in the traditional scientific disciplines.

Prospects for Future Support for Mathematics

In FY 1991, funding for the mathematical sciences will grow by a few percent above inflation. Spending by the Department of Defense, and especially the Universities Research Initiative (URI), accounts for all of this real growth.

The proposed FY 1992 budget for mathematics, and for basic research in general, follows the pattern of recent years (see table at right). Spending on civilian science, including the mathematics programs at the National Science Foundation and the Department of Energy, is proposed to rise considerably over FY 1991 levels, while real reductions are planned for defense basic research, including the five DOD mathematics programs.

However,basic research at NSF and DOE, and thus their mathematical sciences programs, are highly susceptible to congressional budget cuts, especially during FY 1992 as real resources available for domestic discretionary spending shrink. Combined with the flat budgets planned for the DOD mathematics programs, prospects for federal support for mathematics indicate continued stagnation, although if Congress adds funds to DOD basic research accounts, as happened last year, some of the money could be channelled toward the mathematical sciences.

FEDERAL SUPPORT FOR THE MATHEMATICAL SCIENCES

FY 1989-1992, in millions, current dollars

	actual FY 89	actual FY 90	current plan FY 91	budget request FY 92	percent change FY91-92
National Science Foundation					
DMS	$ 66.02	$ 69.12	$ 72.02	$ 79.52	10.4%
Other	8.00	8.00	8.00	8.00	0.0%
TOTAL, NSF	**74.02**	**77.12**	**80.02**	**87.52**	**9.4%**
Department of Defense					
AFOSR	16.45	16.50	17.00	17.00	0.0%
ARO	11.50	12.00	13.50	13.50	0.0%
ONR	12.02	12.70	14.00	14.04	0.3%
DARPA	12.00	12.00	16.00	15.00	-6.3%
NSA	2.86	3.40	3.10	3.00	-3.2%
TOTAL, DOD	**54.83**	**56.40**	**63.60**	**62.54**	**-1.7%**
Department of Energy					
University Support	5.70	6.40	6.70	7.45	11.2%
National Laboratories	6.50	6.50	6.50	7.25	11.5%
TOTAL, DOE	**12.20**	**12.90**	**13.20**	**14.70**	**11.4%**
Other Agencies	**1.00**	**1.00**	**1.00**	**1.00**	**0.0%**
TOTAL, Non-NSF	**68.03**	**70.30**	**77.80**	**78.24**	**0.6%**
TOTAL, All Agencies	**142.05**	**147.42**	**157.82**	**165.76**	**5.0%**

FY 1992 Proposals for Agency Mathematics Programs

The table shown on the previous page gives budget figures for the mathematics programs described below, including estimates of FY 1991 spending and of proposed spending in FY 1992. The accuracy of these figures varies by agency, and the FY 1992 proposals are subject to the congressional budget process to varying degrees. All figures shown in the chart and cited below are in terms of current dollars.

Each funding agency provides support for a variety of activities, including individual and group awards, institutes, equipment, and special programs for women and minorities. Thus, the figures given are not for spending on mathematical research per se, but are funds spent or estimated to be spent by the federal mathematics programs on the various elements of the mathematical sciences enterprise.

National Science Foundation (NSF)

The NSF Division of Mathematical Sciences (DMS) provides almost half of all federal support for the mathematical sciences, funding a spectrum of activities in mathematics research and infrastructure, human resource development, and the diffusion of mathematics into science and technology. Specifically, DMS supports individual investigators, mathematics research institutes, postdoctoral fellowships, research conferences, and undergraduate programs in mathematics.

The mathematics budget will grow by only 4.2 percent in FY 1991, due to the cuts Congress made in the proposed overall NSF research budget. DMS plans to spend $79.52 million in FY 1992, $7.5 million or 10.4 percent above the current plan for FY 1991. Much of the increment will be used to fund activities in support of a number of national initiatives, including increasing the number of new investigators as called for by the Board on Mathematical Sciences; the High Performance Computing and Communications program; and education and human resource development. DMS's role in this last initiative includes funding graduate and undergraduate research as well as undergraduate curriculum development.

Air Force Office of Scientific Research (AFOSR)

Funding for mathematical sciences research in support of the Air Force mission is provided by the Mathematical and Information Sciences Directorate of AFOSR. Of an estimated $23 million to be spent by the directorate in FY 1992, approximately $17 million is planned for mathematical sciences, including Universities Research Initiative programs and roughly $1 million for Air Force laboratory research. This proposed funding level is the same as that for FY 1991.

Army Research Office (ARO)

The mathematics program of the Army Research Office also expects a level budget for FY 1992. It will fund a number of new centers, including one or two in nonlinear analysis, stochastic analysis, and symbolic methods. The Universities Research Initiative will provide approximately $1.7 million for a center for foundations of intelligent systems. Funding for the Army High Performance Computing Research Center will continue.

Office of Naval Research (ONR)

The Mathematical Sciences Division of the Office of Naval Research funds mathematics research in support of the naval mission, with designated programs in the areas of applied analysis, discrete mathematics, numerical analysis, operations research, probability and statistics, and signal analysis. It maintains a core program and also funds accelerated research initiatives (ARI's) as needed.

In FY 1991 the mathematics division plans to spend just over $8 million on the core programs and approximately $4.8 million on ARI's. It also expects to spend roughly $1 million in Universities Research Initiative money. The FY 1992 budget calls for $9.3 million in core program funding, a 13.6 percent increase over FY 1991, and no growth in ARI funding, for a total of just over $14 million. The division does not expect to receive URI funding in FY 1992.

Defense Advanced Research Projects Agency (DARPA)

The Applied and Computational Mathematics program at DARPA is undertaken to support the agency's advanced technology development mission. DARPA funds mathematics research in four areas: modeling and simulation; algorithmic development; digital signal processing; and intelligent control. It should be noted that in this environment some of the research supported transcends the traditional boundary dividing the disciplines of mathematics on the one hand and computer science and engineering on the other.

The current plan for FY 1991 sets spending at approximately $16 million, including just over $11 million for core programs and approximately $5 million in URI funding. The budget for FY 1992 calls for a more than 13 percent increase in the core program, to $12.57 million, and for a decrease in URI funding, to roughly $2.5 million.

National Security Agency (NSA)

The NSA Mathematical Sciences Program experienced its first substantial budget decrease since its inception in 1981. In FY 1990, the program expended a total of $3.4 million on grants in number theory, algebra, discrete mathematics, probability, statistics, and cryptology. The current spending plan for FY 1991 is $3.1 million, a decrease of 9 percent from the FY 1990 level.

Because so many new grants were funded with new money in FY 1990, the support for new grants in FY 1991 will be limited to about two-thirds of the FY 1990 funding level for new grants. Planned FY 1992 spending, $3 million, is slightly less than FY 1991 spending, but includes support for a larger number of new grants.

The Mathematical Sciences Program will begin 1992 with a new program, which will award grants in four categories: the Young Investigators Grant, the Standard Grant, the Senior Investigators Grant, and the Conferences and Special Situations Grant.

Department of Energy (DOE)

The Applied Mathematical Sciences program in the DOE Office of Energy Research is devoted to understanding models arising in DOE research and development programs and at providing supercomputing resources to DOE's researchers.

Growth in DOE's mathematics program was halted in FY 1991 due to congressional action on the overall Office of Energy Research budget. The FY 1992 budget proposal calls for an 11.4 percent increase over the FY 1991 level. Much of this funding would be part of the High Performance Computing Initiative.

In addition, the Office of Energy Research scientific computing branch is proposing to spend $4 million in FY 1992 to facilitate the emergence of computational science, an applications driven discipline drawing from traditional scientific and engineering applications disciplines, computational mathematics, and computer science. The objective is to create a critical mass of computational scientists that can begin to tackle some of the fundamental problems in science and engineering using the advanced computing environments developed by the HPCC program.

Other Federal Agencies

Several agencies, including the National Aeronautics and Space Administration, the National Institutes of Health, and the National Institute of Standards and Technology support mathematical sciences programs, largely as an intramural activity. A rough estimate of $1 million for these programs can be made.

Chapter 22

Computer Science and Engineering Support in the FY 1992 Budget

Computing Research Association

Fred Weingarten

High Performance Computing and Communications

In a seemingly good year for science budgets, computing research fared particularly well. The highlight in the budget, of course, was the *High–Performance Computing and Communications Program* (HPCC), one of three special cross–cutting R&D initiatives and the only one focused on developing a specific set of technologies rather than a policy problem.

Because of this technology focus, the HPCC has been called a first shot by the administration at a "technology policy." It may well have serve that role in the minds of some Administration officials, but the HPCC has its roots in issues raised by the computational research community nearly a decade ago.

In 1982, an ad hoc NSF panel chaired by Peter Lax, an applied mathematician at the Courant Institute, pointed out the growing importance of computers to scientific research across the board and decried the lack of access to so–called "supercomputer–class"[1] machines by the U.S. academic research community. Beyond simple lack of access, the Lax Report[2] identified several major critical research problems for which even the best machines then available would be inadequate. The report called for a program to make high–performance computing more available to researchers, to accelerate the development of the next generations of machines, to develop improved software tools for computational research, and to create a high–speed data network for researchers to use for access to the high–performance systems and data bases.

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[1] Supercomputers are machines generally considered to be the most powerful available for certain wide classes of problems. Since comparing the power of different computers is imprecise, this is a general, broad definition, at best.

[2] Peter D. Lax, *Report of the Panel on Large–Scale Computing in Science and Engineering* (Washington, D.C., National Science Foundation, 1982).

In response to this and similar reports, and with the encouragement of key congressional committees, NSF initiated an advanced computing systems program in 1984 that created several national supercomputer centers and began to expand the capabilities of its fledgling science network. DARPA, NSF, and, eventually, other science agencies began informal coordination and cooperation in both developing their computer architecture research programs and their networking. Indeed, an elaborate web of interconnected national, regional, state, and local networks serving the scientific community is already in place and growing rapidly. International connections exist both to Japan and Europe.

During this same time period, political concerns arose about the competitive challenge, particularly by the Japanese firms, to U.S. supercomputer manufacturers. Thus, an additional line of justification and need was added to these programs, and the HPCC retains that dual flavor today—(1) bolster the competitiveness of U.S. information technology industry and (2) create an advanced information infrastructure for the research community. The current Administration budget proposal is clearly framed in terms of "technology policy."

An additional strain that has appeared and that is reflected between the lines of the HPCC budget request is the growing demand from outside the research community for a network to serve their needs. The network was originally known as the "National Research Network (NRN)." It is now called the "National Research and Education Network (NREN)," and NSF plans to explore applications of it for K-12 education. This widening demand has created a much broader constituency for building the network, but also can potentially create technological, funding, and management strains for the science agency or agencies responsible for getting NREN put in place.

These historical roots, of course, do not diminish the importance of the special program in this budget, which calls for a 30% increase in funding from a $489.4 million estimated baseline in FY 91 to $638.3

million proposed in FY 92. The funds are allocated among eight agencies. Four of them (NSF, DARPA, Energy, and NASA) are responsible for basic technological development; three (NIH/NLM, EPA, and NOAA) participate with programs that stress scientific applications; and NIST is concerned with standards development mainly focused on high speed data communications.

The program is divided into four basic components as described in the supplementary budget document, *Grand Challenges: High-Performance Computing and Communications*.[3]

1. **High Performance Computing Systems (HPCS)**—"the development of the underlying technology required for scalable parallel computing systems capable of sustaining trillions of operations per second on large problems." This component is directed at R&D that will underpin future generations of very high speed computer systems that are roughly two orders of magnitude more powerful than the best now available. Although sometimes referred to as the "hardware" program, this component would also support research on system software.

2. **Advanced Scientific and Technological Applications (ASCT)**—"the development of generic software technology and algorithms for grand challenge research applications to realize the performance potential of high performance computing systems in a networked environment." This component would be focused both on developing new software and algorithms and on advancing the underlying science of using computers as research tools in science and engineering.

3. **National Research and Education Network (NREN)**—"the development of a national high speed network to provide distributed computing capability to research and educational institutions and to further advance research on very high speed networks and applications." Because of its focus on infrastructure development, this component faces the stiffest challenge in the form of interagency coordination, management and policy setting, and accommodating the line between federally funded communication services and the private telecom marketplace.

4. **Basic Research and Human Resources (BRHR)**—"support for individual investigator and multidisciplinary long-term research drawn from diverse disciplines, including computer science,

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[3] Available from the Computer and Information Science and Engineering Directorate of the National Science Foundation.

computer engineering, and computational science and engineering; initiation of activities to significantly increase the pool of trained personnel; and support for efforts leading to accelerated technology transition." As can be seen from the somewhat tortured syntax of the description, this category is quite broad, encompassing several goals. Basically, it recognizes that the first three goals cannot be achieved as development efforts without a concomitant long–term program of more fundamental research and education; and, recognizing that need, it specifically lays out funding levels for that purpose.

Table 1 gives a breakdown of HPCC expenditures by major program area and by agency. NSF, NASA, DARPA, and Energy all have broad mandates that span all four research components of the program. DARPA has particular responsibilities for R&D leading to the teraops computer systems, and for gigabit communications technology NSF has key responsibility under this plan for deploying and coordinating NREN.[4]

National Science Foundation

Benefitting both from the HPCC programs and the relatively large base increases the agency received for basic research, programs in the NSF Computer and Information Science and Engineering Directorate (CISE) show healthy gains (Table 2). The three divisions that focus on basic research project funding, CCR, IRIS, and MIPS show increases in the 26% to 27% range. In CCR, "Numerical, Symbolic, and Geometrical Computation" received the largest increase, with "Computer Systems" not far behind. (Since this division is reshuffling its programs a bit, it is difficult to discern much pattern, although one could argue the influence of the HPCC on research priorities.) In IRIS, "Knowledge and Database Systems" received a numerically big increase of $2.5 million. In MIPS, "Experimental Systems" was the largest increase, in absolute terms and in percentage.

NCRI, the division responsible for implementing the National Research and Education Network, shows a 41% increase that is, at first glance, startling. However, the increase is atop a smaller base than that of the research divisions and is, therefore, smaller in absolute terms; and it mainly reflects the incremental cost to upgrade the capacity of the network next year. ASC, which supports the NSF supercomputer centers, shows a more modest 13% growth. Cross–Disciplinary Activities (CDA) shows a 22% growth, principally reflecting its increased level of funding for institutional infrastructure.

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[4] This assignment of NREN to NSF may be somewhat controversial in the Congress. Although it conforms with the Gore Bill (S. 272), legislation has been introduced in the Senate (S. 343) that would give the Department of Energy principal responsibility.

Other

Computers are "enabling technology" for other research disciplines and mission agencies. Thus, a great deal of computing research support is allocated among the various projects and mission it can be particularly hard to peel out from initial budget documents exactly what levels of spending are proposed in that area. **NASA** is particularly difficult in this respect. Clearly, the agency is vitally dependent on advanced computer technology to do its work. As a result, support of computer science and engineering, as well as computational science, is distributed through a number of projects and organizational units.

DARPA budgets for computing research have been relatively flat for the last two years, subject as the agency is to the vicissitudes of overall Defense spending. The $49.2 million increase contained in the HPCC, then, would be a major boost to DARPA spending on information technology (roughly $250 million last year).

ONR support for computer science will drop from $15 million to $12 million with the termination of a number of university block funded programs.

Table 1: High Performance Computing and Communications Cross Agency Funding (in $Millions)

Agency	FY 1991	FY 1992 Total	FY 1992 by Program			
			HPCS	ASTA	NREN	BRHR
DARPA	183.0	232.2	103.3	38.5	32.9	57.5
DoE	65.0	93.0	15.0	58.0	12.0	8.0
NASA	54.0	72.4	14.2	49.8	7.4	1.0
NSF	169.0	213.0	24.0	103.0	32.7	53.3
DoC/NIST	2.1	2.9	0.3	0.6	2.0	0.0
DoC/NOAA	1.4	2.5	0.0	1.8	0.7	0.0
EPA	1.4	5.2	0.0	4.5	0.0	0.7
NIH/NLM	13.5	17.1	0.0	8.9	4.2	4.0
Total	489.4	638.3	156.8	265.1	91.9	124.5

TABLE 2: NSF CISE Funding Allocation among Programs
(in Thousands of Dollars)

CISE Division	FY 90	FY 91 (req)	FY 91 (est)	FY 92 (req.)	Delta	% Delta
CCR	21,966	24,280	24,207	30,780	6,573	27
IRIS	19,965	22,880	22,763	28,640	5,877	26
MIPS	16,598	18,870	18,499	23,500	5,001	27
ASC	62,792	62,580	62,067	70,400	8,333	13
NCRI	22,326	31,290	29,803	42,240	12,437	41
CDA	19,621	24,030	20,010	24,520	4,510	22
S&TC	6,574	9,320	8,766	9,420	654	7

Legend:

CISE: Computer and Information Science and Technology
CCR: Computer and Computation Research
IRIS: Information, Robotics, and Intelligent Systems
MIPS: Microelectronic Information Processing Systems
ASC: Advanced Scientific Computing
NCRI: Networking and Communications Research and Infrastructure
CDA: Cross-Disciplinary Activities
STC: Science and Technology Centers

Chapter 23

Electrotechnology-Related Research in the FY 1992 Budget

Institute of Electrical and Electronics Engineers

Chris J. Brantley

Electrical and electronics technology (i.e., "electro-technology") are key components of the Bush Administration's strategy of enhancing federal research and development (R&D). The Administration's FY 1992 budget request to Congress includes significant new funding for electrotechnology-related research involving high performance computing and communications, energy supply technologies, manufacturing & materials, fusion energy, aeronautics R&D, and the programs of the National Institute of Standards and Technology.

This report provides an overview of proposed R&D funding levels and highlights those electrotechnologies which are significantly affected by the Administration's budget proposal. It is not intended to be all-inclusive, as time and space limitations preclude reporting on all relevant programs relating to electrotechnology within the $71.3 billion in federal R&D obligatory authority requested for FY 1992. Rather, the report highlights funding requests and electrotechnology programs in the Departments of Defense and Energy, the National Aeronautics and Space Administration, the National Science Foundation, and the National Institute of Standards and Technology.

The analysis has been prepared primarily on the basis of budget figures provided by the federal departments and agencies on February 5, 1991, when the Administration's budget was released to Congress. The figures are expressed in current dollars so that requested increases or decreases do not reflect the impact of inflation.

DEPARTMENT OF DEFENSE

The Department of Defense (DoD) budget request for Research, Development, Test and Evaluation (RDT&E) is slated to increase 15.5 percent to $39.9 billion in FY 1992. The DoD's RDT&E budget and defense-related research performed by other agencies comprises approximately 60 percent of the total federal R&D budget.

Technology Base programs, that component of RDT&E traditionally devoted to basic research and development activity, increases a half percent to $3.87 billion and includes a 10 percent decrease for Research (to $1 billion) and a 5 percent increase for Exploratory Development (to $2.86 billion). The balance of the RDT&E budget, including advanced development, engineering development, operational systems development, and management and support, would increase by approximately 17 percent to $36.05 billion.

Allocation of these funds varies through the Triservices and Defense Agencies. Below is a brief overview with highlights of technology base and advanced technology development program elements of particular relevance to electrical and electronics engineering:

Army

Total funds allocated for Army RDT&E would increase 16 percent to $6.24 billion in FY 1992. The allocation for Army Research would total $197.1 million, an increase of 8 percent over FY 1991. Exploratory Development decreases 1 percent to $622.6 million. Among programs of interest:

• Electronic Survivability and Fuzing Technology	- 20%	$19.8 million
• Laser Weapons Technology	+ 840%	$ 5.2 million
• Electronics and Electronic Devices	- 16%	$19.9 million
• Command, Control & Communications (C^3)	- 5%	$12.7 million
• Computer and Software Technology	+ 52%	$ 5.7 million
• Artificial Intelligence	(New)	$ 3.3 million

Advanced Technology Development would decrease almost 6 percent to $485 million. Among programs of interest:

C^3 Advanced Technology	+ 38%	$12.7 million
Electronic Warfare Tech.	+ 6%	$ 7.1 million
Missile and Rocket Advanced Technology	+ 123%	$19.5 million
Night Vision Advanced Technology	+ 13%	$22.6 million
Advanced Electronic Devices Development	- 47%	$ 4.0 million
Advanced Tactical Computer Science and Technology	+ 80%	$ 8.6 million

Navy

The Navy's RDT&E budget decreases 2 percent to $8.2 billion in FY 1992. Technology Base funding would increase to $942 million, with equal 7 percent increases for Research ($421.6 million) and Exploratory Development ($520.5 million). Among Technology Base programs of interest:

Defense Research Sciences	+ 7%	$395.8 million
C^3 Technology	+ 7%	$ 19.6 million
Electronic Warfare Tech.	+ 9%	$ 14.0 million
ASW Technology	+ 5%	$140.9 million
Nuclear Propulsion	+ 5%	$ 15.3 million

Advanced Technology Development increases by 8 percent to $221.1 million, with several programs showing changes:

EW Technology	(New)	$ 4.9 million
Electromagnetic Radiation Sources Elimination	- 10%	$ 5.1 million
Electric Drive	- 100%	$ 0.0 million
Simulation and Training Devices	+ 3%	$ 5.2 million
Advanced ASW Technology	+ 164%	$ 42.9 million
C^3 Advanced Technology	(New)	$ 1.4 million

Air Force

Air Force RDT&E would increase by approximately 2 percent in FY 1992 to $15.2 billion.

Technology Base funding would grow by 9 percent to $855.8 million, including a 5 percent increase for Research ($213.2 million) and a 11 percent increase for Exploratory Development ($642.6 million). Among programs of interest:

• Aerospace Avionics	+ 23%	$ 83.1 million
• Rocket Propulsion and Astronautics Tech.	+ 27%	$ 47.3 million
• C^3	+ 12%	$ 88.7 million

Advanced Technology Development would increase by 18 percent to $818.4 million. Within this category, several programs showed significant increases:

• Advanced Avionics for Aerospace Vehicles	+ 18%	$ 38.0 million
• Advanced Avionics Integration	+ 30%	$ 19.5 million
• National Aerospace Plane	+ 44%	$231.8 million
• EW Technology	+ 3%	$ 35.8 million
• C^3I Subsystem Integration	+ 4%	$ 9.5 million
• Advanced Computer Tech.	+ 13%	$ 9.9 million
• C^3 Advanced Development	+ 4%	$ 9.6 million

Defense Agencies

RDT&E across the Defense Agencies would increase by 13.6 percent to $9.25 billion. Two of the three primary defense R&D funding agencies are slated for increases.

The Strategic Defense Initiative Organization (SDIO) remains the federal government's largest single R&D initiative, with a proposed increase of 80 percent to $5.2 billion in FY 1992. Although all SDIO research is classified as Advanced Development, there is a significant element of basic research. SDIO program lines include:

• Phase I Defenses	+ 86%	$1.6 billion
• Limited Protection Systems	+ 72%	$674 million
• Theater and ATBM Defenses	+ 55%	$279 million
• Follow-On Systems	+ 33%	$925 million
• Research and Support Activities	+ 49%	$1.1 billion

The Defense Nuclear Agency would also increase 20 percent to $524 million. This includes Technology Base funding of $441 million, up 34 percent, and $83 million for Verification Technology Demonstrations, a decrease of 22 percent.

The Defense Advanced Research Projects Agency (DARPA) would suffer a 20 decrease to $1.17 billion. DARPA Technology Base programs would decline 22 percent to $594.9 million. Among programs affected:

• Strategic Technology	+ 112%	$268 million
• Tactical Technology	- 8%	$118 million
• Partical Beam Technology	- 79%	$ 3 million
• Integrated Command and Control Technology	- 68%	$ 36 million
• Materials and Electronics Technology	- 60%	$ 62 million

Advanced Technology Development within DARPA also declines, by 15 percent to $549.9 million. Increases were provided for:

• Experimental Evaluation of Major Innovative Tech.	+ 65%	$289 million
• Manufacturing Technology (including SEMATECH)	+ 106%	$206 million
• Consolidated DoD Software Initiative	+ 27%	$ 44 million

Funding was eliminated for Precompetitive Technology, Microwave/Millimeteer Eave Monolithic Integrated Circuits, Prototyping of Advanced Technologies and Innovative Concepts, and Infrared Focal Plane Array.

DEPARTMENT OF ENERGY

Total FY 1992 budget authority for the Department of Energy (DOE) would increase 5 percent to $18.57 billion. Defense-related programs, including weapons research, defense materials production, and environmental restoration and waste management, represent approximately 63 percent of the Department's budget.

The President's FY 1992 budget request highlights advancing new energy technologies as a major element of the proposed National Energy Strategy (NES), noting that total investment in energy technology R&D will increase by 34 percent to $903 million in support of NES initiatives government-wide. DOE initiatives include development of new transportation fuels, increased energy efficiency in buildings and industry, and advanced electricity technology.

The DOE's request for Energy Supply R&D increases by 12 percent to $2.8 billion. Funding for Solar Energy and Renewables rises 10 percent to $142.9 million and includes increases of 10 percent for photovoltaic energy systems ($50.8 million), 4 percent for solar thermal technology ($20 million), and 11 percent for biofuels ($36.8 million). Funding for wind energy systems would increase by 26 percent to $13.9 million, while funding for ocean energy systems is eliminated. Funding for solar building energy systems would decrease by 49 percent to $1 million. The Solar Energy Research Institute would receive $11.5 million.

Geothermal Energy drops 26 percent to $20.2 million. Just over $1 million is requested for Hydropower Energy to complete studies of hydropower regulatory and licensing policies and practices.

Funding for Electric Energy Systems increases 10 percent to $30.8 million while Energy Storage Systems decreases 43 percent to $7.25 million. Included is $5 million for continued study of the potential health effects of electric and magnetic fields associated with power transmission and $2.6 million in new funds for hydrogen research. Cuts are targeted on vehicle applications.

Funding for Nuclear R&D Activities would increase by 31 percent to $398 million. Light water reactor research jumps 63 percent to $62.5 million. Advanced Reactor R&D declines 13 percent to $49.5 million. Nuclear facilities would receive $127.8 million, an increase of 39 percent. The Nuclear R&D budget also proposes a 25 percent decrease for Advanced Radioisotope Power Systems ($56 million), an increase of 68 percent for space reactor power systems ($56 million), and $30 million in new funding for nuclear propulsion systems for the Space Exploration Initiative.

The budget proposes $337 million for Fusion research, an increase of 23 percent for technology development targeted toward the goal of an operating demonstration plant by 2025. The request provides $328.9 million for Magnetic Fusion and $8.2 million for Inertial Confinement research.

The FY 1992 request for Fossil Energy R&D would decrease by 51 percent to $227 million, and would include $150 million transferred from an advance appropriation for Clean Coal Technology Round 5 solicitations. Three programs are slated for increases: advanced petroleum extraction and process technology (up 47 percent to $14.8 million); enhanced oil recovery (up 18 percent to $37.3 million), and fossil energy environmental restoration (up 1000 percent to $8.1 million). Similarly, Clean Coal Technology would decrease by 19 percent to $315 million, with funding provided for the fourth round of proposal solicitations.

DOE Energy Conservation programs are restructured by sector and are supported by an FY 1992 budget request of $296 million, an overall decrease of 34 percent with cuts focused on DOE's Technical and Financial Assistance programs. Increases are slated for Building Technologies (up 26 percent to $54.2 million), Industry Technologies (up 22 percent to $101.9 million), Transportation Technologies (up 33 percent to $111 million), and Utility Technologies (up 60 percent to $6.8 million).

DOE's General Science and Research budget would rise by 74 percent to $1.55 billion. The principal beneficiary is the Superconducting Super Collider which would increase by 120 percent to $533.7 million with new funds for capital equipment and construction. Funding for High Energy Physics increases 13 percent to $666.4 million while Nuclear Physics funding would increase by 9 percent to $342.4 million.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Administration proposes a FY 1992 budget of $15.75 billion for the National Aeronautics and Space Administration (NASA), an increase of $1.9 billion or 13 percent. The request includes $7.2 billion for research and development programs, an increase of $1.17 billion.

As a linchpin of NASA's Mission From Planet Earth program, Space Station Freedom is slated to receive $2.03 billion, an increase of $128 million or 7 percent, consistent with proposed reductions in size and complexity.

A total of $879.8 million, an increase of 46 percent, is requested for Space Transportation Capability Development, including $175 million in new funding matched by DoD for development of a new expendable heavy launch vehicle.

Space Science and Applications would increase by 21 percent to $2.9 billion. New funds go to Physics and Astronomy (up 17 percent to $1.14 billion), Life Sciences (up 34 percent to $183.9 million), and Planetary Exploration (up 38 percent to $627.3 million including $328 million for the Comet Rendezvous Asteroid Flyby/Cassini missions).

Earth Science and Applications increases 16 percent to $775.6 million. The Earth Observing System (EOS) would receive $336 million, up 76 percent, with increases for instruments (up 103 percent to $159.9 million) and EOS Data Information Systems (up 130 percent to $82.6 million).

The NASA budget request provides $39.4 million for Space Communications, a decrease of 25 percent. NASA support for Commercial Programs increases by 75 percent to $150 million, with $32 million directed toward technology utilization and $118 million for commercial uses of space.

Funding for Aeronautics Research and Technology would increase by 16 percent to $591.2 million, including $17 million for high performance computing and $73 million for NASA's share in developing the National Aerospace Plane.

Space Research and Technology would increase by 46 percent to $421.8 million, and includes $141.6 million for technology base research (up 13 percent), $114.3 million for the Civil Space Technology Initiative, $52 million for Exploration Technology (up 95 percent), and $15 million for Exploration Mission Studies. A new Automation and Robotics budget line funded at $82.9 million includes $14.8 million for telerobotics, $13.1 for artificial intelligence research, and $55 million for the Flight Telerobotics Servicer transferred from the space station account.

NATIONAL SCIENCE FOUNDATION

To meet the President's goal of doubling the NSF budget by 1994, the Administration has proposed an FY 1992 NSF budget of $2.72 billion, an increase of 17.5 percent.

Funding for NSF's research programs would increase by 17 percent to $1.96 billion. Key research initiatives include high performance computing and communications, global climate change research, and materials synthesis and processing. High priority is also given to support for research grants to individual investigators.

The Engineering Directorate increases 14.8 percent to $247.7 million in FY 1992. Funding for Electrical and Communications Systems would increase by 16 percent to $37 million. Funding for Engineering Research Centers increases 6 percent to $48.3 million with no new centers planned and $6.9 million would be provided for Industry/University Cooperative Research Centers. Funding for Engineering Infrastructure Development would increase by 28 percent to $25.6 million to promote engineering education coalitions.

The Computer and Information Science and Engineering Directorate is slated for a 23.3 percent increase to $229.5 million. Of this total, $208 million would support the Administration's high performance computing initiative $24 million for high performance computing systems, $100 million for advanced software technology, $33 million for development of the National Research and Education Network, and $51 million for basic research and human resources.

In other areas, funding in the Geosciences Directorate for global climate change research would increase by 45 percent to $84.9 million. Total NSF funding for global change research would increase 36 percent to $118.5 million. NSF's Research Facilities Modernization program would be replaced by a $50 million Presidential initiative for Academic Research Instrumentation. Also requested is $24.5 million for Small Business Innovative Research programs and $15 million for the Experimental Program to Stimulate Competitive Research (EPSCOR). Finally, the NSF budget request also includes $390 million, an increase of 21 percent, for the Education and Human Resources Directorate.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

The Administration has requested a FY 1992 budget of $248 million for NIST, an increase of $35.6 million or 15.2 percent. The request is on target with the President's goal of doubling the NIST budget appropriation by FY 1996. NIST also anticipates $214 million in revenue from contract research, fees, and in-kind loans of staff and equipment for a total resources budget of $462 million.

The FY 1992 budget request provides $201.8 million for NIST's intramural research programs and facilities, an increase of $35.6 million or 21.4 percent over FY 1991.

NIST's intramural budget for electronics and electrical engineering research would increase by 57.9 percent to $33.6 million. Additional funding is targeted for magnetic measurement technology, superconductivity, development of measurement methods and standards for microwave products, and enhancement of the lightwave measurement program.

The intramural budget for manufacturing engineering would increase by 52.6 percent to $12.6 million and would provide additional funding for intelligent machine systems and implementation of an international product data exchange standard (PDES/STEP).

Computer systems is slated to receive $11.8 million, a 27.3 percent increase. Initiatives include expansion of computer security research and acceleration of standards work on an Integrated Services Digital Network (ISDN)

Funding for NIST's extramural programs would decrease by 5.9 percent to $46.2 million. Funding for the Advanced Technology Program to support precompetitive generic technology development would remain level at $35.9 million. NIST's Manufacturing Technology Centers Program would receive $10.3 million, a 13.5 percent decrease offset in part by carryover of $3.4 million in unexpended FY 1991 funds. The budget eliminates funding for the State Technology Extension Program.

The FY 1992 NIST request also includes $4 million for refurbishment of aging laboratory facilities in Gaithersburg, Maryland and Boulder, Colorado.

Chapter 24

Chemical Engineering in the FY 1992 Budget

American Institute of Chemical Engineers

J.R. Hightower, Betsy Houston

This chapter attempts to identify and report on federal programs from which chemical engineers receive "significant" support. Because the budget of the United States does not specifically identify chemical engineering support, the authors draw on their experience and program descriptions given in budget justification documents for this estimate. The depth of the analysis of selected federal programs affecting chemical engineers reflects the extent to which sources were available and there was time for the authors to exploit them.

Data were obtained this year for the Department of Energy (DOE), National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Nuclear Regulatory Commission (NRC). These data indicate that spending on programs supporting chemical engineers would increase by 6.8 percent from $8.8 billion to $9.4 billion in FY 1992. As in the past, the totals are dominated by the DOE programs.

Department of Energy

Funding for programs important to chemical engineers in DOE is shown in Table 1. Overall, the programs increase 4.7 percent from $8.42 billion in FY 1991 to $8.82 billion in FY 1992. Important increases are seen in Biofuels Energy Systems, Basic Energy Sciences, Light Water Reactors, Space Power Systems, New Production Reactors, and (because of the large magnitude of the programs) in Environmental Restoration and Waste Management and in Uranium Enrichment. General decreases are seen in Clean Coal Technology, and Fossil Energy Research and Development.

National Science Foundation

Budgets for programs in the NSF that support chemical engineers are shown in Table 2. Overall, spending for these programs is expected to increase by 13.3 percent, with all areas showing an increase. The Engineering request provides significant growth for research, performed by individual investigators and small groups. Research on the synthesis and processing of advanced materials is being emphasized.

Engineering centers will receive increased funding to 1) bolster support for existing Engineering Research Centers, 2) provide additional Industry/University Cooperative Research Centers, through the States initiative. Undergraduate engineering education activities will be significantly enhanced primarily through the start of new engineering coalitions.

Environmental Protection Agency

Total support for programs important to chemical engineers in the EPA is expected to increase significantly, due primarily to the passage of the new Clean Air Act. The objectives of the 1992 research and development budget are to: (1) improve EPA's scientific ability to address new statutory requirements, (2) improve understanding of the effects of pollution on the country's ecological resources, and (3) improve information available to the agency's decision makers.

Increases in the budget for Air Research are provided primarily for the 1990 Clean Air Act Amendments (CAAA) and the U.S. Global Climate Change Research Program. The CAAA calls for research on ozone nonattainment, mobile sources, air toxics, and acid deposition. Increases are also provided to expand indoor air quality research by developing diagnostic protocols and monitoring techniques, and evaluating novel ventilation strategies to mitigate indoor air pollution.

The increase in the multimedia research budget is provided to enhance risk-based media research, strengethen the agency's long-term "core" research program, and continue rebuilding the agency's aging scientific infrastructure.

Nuclear Regulatory Commission

NRC programs of interest to chemical engineers are primarily in the Nuclear Safety Research programs under the program elements (1) Reactor Containment Performance, (2) Confirming the Safety of Low-Level Waste Disposal, and (3) Resolving Safety Issues and Developing Regulations. The subelements of specific interest are listed in Table 4 although budget assignments for these lower program elements were not available. As seen in Table 4, these programs increase 9.5 percent overall, but the components of this overall result consist of decreases in Program Elements (1) and (2) and a 33.8 percent increase in Program Element (3).

TABLE 1 DEPARTMENT OF ENERGY
($ in millions)

	FY 1991	FY 1992	Change
ENERGY SUPPLY RESEARCH AND DEVELOPMENT			
SOLAR AND OTHER RENEWABLES			
Biofuels Energy Systems	33.127	36.800	11.1
Ocean Energy Systems	2.715	0.000	-100.0
Solar Thermal Energy Technology	19.253	20.019	4.0
NUCLEAR ENERGY R&D			
Light Water Reactors	38.276	62.500	63.3
Advanced Reactor R&D	56.668	49.539	-12.6
Space Reactor Power Systems	33.305	56.000	68.1
Advanced Radioisotope Power Systems	75.061	56.000	-25.4
BASIC ENERGY SCIENCES			
Materials Sciences	228.127	257.116	12.7
Chemical Sciences	157.585	158.300	0.5
Engineering and Geosciences	32.310	35.800	10.8
CLEAN COAL TECHNOLOGY	391.000	315.000	-19.4
FOSSIL ENERGY RESEARCH AND DEVELOPMENT			
COAL			
Control Technology and Coal Prep.	55.724	22.520	-59.6
Advanced Research and Technology Dev.	31.376	28.865	-8.0
Coal Liquefaction	42.677	17.152	-59.8
Combustion Systems	36.909	18.676	-49.4
Surface Coal Gasification	40.039	0.000	-100.0
PETROLEUM	59.033	52.175	-11.6
ATOMIC ENERGY DEFENSE ACTIVITIES			
URANIUM ENRICHMENT*	1342.328	1547.000	15.2
TOTAL DOE	8421.583	8815.362	4.7

* Funded through sales of enriched uranium.

TABLE 2 NATIONAL SCIENCE FOUNDATION
($ in millions)

	FY 1991	FY 1992	Change
CHEMICAL AND THERMAL SYSTEMS			
Chemical Reaction Processes	6.980	9.360	34.1
Interfacial, Transport, and Separation Processes	8.730	9.900	13.4
Thermal Systems	8.110	9.150	12.8
Fluid, Particulate, and Hydraulic Systems	9.190	9.850	7.2
MATERIALS			
Materials Research Project Support	69.630	80.230	15.2
ENGINEERING CENTERS			
Engineering Research Centers	45.770	48.270	5.5
Industry/University Cooperative Research Centers	4.900	6.900	40.8
TOTAL NSF	153.31	173.66	13.3

TABLE 3 ENVIRONMENTAL PROTECTION AGENCY
RESEARCH AND DEVELOPMENT PROGRAMS
($ in millions)

	FY 1991	FY 1992	Change
Research Media Program			
AIR	86.600	112.400	29.8
ENERGY/ACID RAIN	13.700	13.700	0.0
WATER QUALITY	27.700	28.900	4.3
DRINKING WATER	20.700	22.200	7.2
PESTICIDES	12.600	15.000	19.0
TOXIC SUBSTANCES	25.400	26.200	3.1
HAZARDOUS WASTE	39.200	43.600	11.2
MULTIMEDIA	124.200	150.700	21.3
TOTAL EPA	225.900	412.700	82.7

TABLE 4 NUCLEAR REGULATORY COMMISSION
($ in millions)

	FY 1991	FY 1992	Change
NUCLEAR SAFETY RESEARCH			
REACTOR CONTAINMENT PERFORMANCE Core Melt and Reactor Coolant System Performance Reactor Containment Safety	17.330	15.132	-12.7
CONFIRMING THE SAFETY OF LOW-LEVEL WASTE DISPOSAL Materials and Engineering	3.301	3.000	-9.1
RESOLVING SAFETY ISSUES AND DEVELOPING REGULATIONS Fuel Cycle, Transportation, and Safeguards	18.364	24.573	33.8
TOTAL NRC	38.995	42.705	9.5

Chapter 25

R&D in Materials Science and Engineering

Federation of Materials Societies

Betsy Houston

Materials research and development in the proposed FY 1992 budget continues to be funded at about $1.6 billion in the programs analyzed in this report. A major increase comes in the National Science Foundation, with $84 million earmarked for a cross-directorate program for R&D in materials synthesis and processing. This reflects recommendations made by the National Research Council's report on materials science and engineering, and the Federation of Materials Societies' 11th Biennial Conference on National Materials Policy. As in past years, sufficient detail (most notably from the Department of Transportation) was not available at the time this report was written to include all programs with materials components.

MATERIALS R & D
($ in millions)

	FY 1990	FY 1991	FY 1992
NSF	183.55	194.82	228.72
DOE	429.60	575.41	533.12
NASA	281.66	326.41	350.00
DoD	362.11	472.09	492.05
NIST	23.16	26.50	28.67
BuM	26.44	26.86	25.45
	1,306.52	1,622.09	1,658.01

National Science Foundation

The National Science Foundation traditionally has provided about half of the federal support for University-based research in the fields of materials science and engineering. The FY 1992 materials synthesis and processing initiative cuts across the directorates of Biological, Behavioral and Social Sciences; Mathematical and Physical Sciences; and Engineering, raising the total NSF commitment to materials synthesis and processing from $59 million in FY 1991 to $84 million in FY 1992.

In Biological, Behavioral and Social Sciences, $6 million will focus on the design, synthesis, and structural analysis of biomolecular materials, for example, adhesive proteins, photoresponsive membranes, and biodegradable materials.

In Mathematical and Physical Sciences, the Materials Research subactivity will increase 11.4 percent to $136.58 million. This program supports research to advance the fundamental understanding of the physics and chemistry of materials, to promote the development of new materials with novel or superior properties, and to further the understanding of interrelationships among synthesis and processing, structure and composition, properties, and performance of materials at molecular, microscopic, and macroscopic levels. An increment of $10.6 million for Materials Research Project Support will be used to enhance individual investigator research in areas such as synthesis and processing of advanced materials, primarily biomolecular, electronic and photonic materials. Included in this amount is an increase of $1 million for research on high temperature superconductivity. An increment of $2 million will enable the establishment of one additional Materials Research Laboratory (for a total of 10) and one additional Materials Research Group (for a total of 17). The requested increase of $1.4 million for the National Facilities and Instrumentation Program will be used to strengthen, upgrade and complete construction of existing user facilities, and to support the acquisition of additional major equipment for shared use.

In the Chemistry Subactivity, an increment of $3.1 million will be used for new projects in materials synthesis and processing, with potential fields of processing being semiconductors, advanced ceramics, and optical, electronic and biomolecular materials.

In the Engineering Directorate, $35.5 million will be devoted to the cross-directorate materials synthesis and processing initiative. Special emphasis will be given to small multidisciplinary groups and individual investigators working on novel electronic, photonic and biomolecular materials. In the Biological and Critical Systems Subactivity, $1.77 million is earmarked for the synthesis and processing of novel biological materials, including new biopolymers such as unique proteins, adhesives, and biodegradable polymers, tissue replacement materials, biosensors and bioelectronic materials. In the Chemical and Thermal Systems Subactivity, a $3.75 million increment will support the synthesis and processing initiative. This will involve techniques such as sol-gel processing, chemical vapor deposition and molecular beam epitaxy; synthesis of microporous membranes for bio-separations and for removal of hazardous chemicals; and the development of thin films and coatings with commercially attractive properties. In the Electrical and Communications Systems Subactivity, a $3.45 million increment will support research on synthesis and processing of new materials for electronic and photonic technologies. The Mechanical and Structural Systems Subactivity includes increases targeted at advanced polymeric materials for application in utility systems; new computational methodologies for the characterization and synthesis of material performance in the mechanical domain; new high technology coatings and layers to increase tribological performance; and quantitative nondestructive evaluation of materials. In the Design and Manufacturing Subactivity, a $1.0 million increase will allow expansion of materials processing research to cover such topics as near net shape methods of fabricating parts.

Department of Energy

Overall, the FY 1992 request for materials R&D is decreased by over $40 million in the Department of Energy. A large part of this decrease appears to come as a result of completion of programs.

In the Fossil Energy program, funding is continued for structural ceramic composites and other advanced materials to permit the mid- and long-term development of more economic, efficient and clean fossil fuel systems. However, the heat engines sub-program is zeroed out, with DOE saying that "program efforts through FY 1991 will provide sufficient technical parameters to allow decisions to be made by industry concerning potential commercialization of the technologie ."

In the Energy Conservation program, funds are provided in the Buildings Sector for the development of superinsulating materials; in the Industrial Sector for increasing the energy efficiency of major processes to enhance the productivity of the steel, aluminum, foundry and glass industries, and for continuous fiber ceramic composites, engineered industrial materials, and materials manufacturing technologies. In the Transportation Sector, the materials development program focuses on ceramic technology, materials technology other than high temperature structural ceramics, tribology, and the High Temperature Materials Laboratory. Here the heat engine activity shows a slight increase.

Funding for R&D on superconductivity magnets under the Superconducting Super Collider program under General Energy Sciences decline in the FY 1992 budget as a result of progress made in past years.

In the Energy Supply, Research and Development program, funding is continued for materials R&D in solar building technology research, photovoltaic systems, solar thermal energy systems, electric energy systems (primarily for high temperature super--conductivity), and energy storage systems.

NASA

Materials related R&D in NASA is projected to increase by almost $25 million, to $350 million. The Materials Processing in Space program will receive the largest increase, with investigations planned in fluid dynamics, glasses, electronic materials, biotechnology, metals and alloys, and combustion. Although the National Aerospace Plane shows a decrease, materials development and charaterization remains a significant part of technology development. In the Space Research and Technology program, the FY 1992 program will emphasize evaluation of materials systems returned from the Long-Duration Exposure Facility. The Aeronautical Research and Technology program will continue to focus on enabling the design of safe, lightweight airframes and lightweight, durable, fuel-efficient engines.

Department of Defense

DoD is a major supporter of materials R&D across all its programs. Because of the breadth of involvement, it is impossible to pinpoint all the funding for materials. For example, while the various departments label one figure "materials," there are also materials-directed funds included in "aircraft technology" initiatives and other programs including specific weapons systems which could not be identified with the figures available at the time this analysis was prepared. However, a rough estimate shows that materials related R&D may have stayed essentially the same as the FY 1991 level.

National Institute of Standards and Technology

In FY 1992, the NIST Materials Science and Engineering program will:

- Develop in-process sensors and process models to control microstructural properties and overall design quality of continuous rolled sheet steel products. Develop principles of ntelligent process control for use by member companies within the NIST/American Iron and Steel Institute (AISI) working group. This technology will provide the means to reduce coil-to-coil variability of properties, thus increasing quality.

- Develop test methods, data and concepts of performance to define effects of environment on long-term performance charcteristics of polymer composites. Develop, test, and refine ultrasonic transducer, detector, and analytical methods to model acoustic wave propagation in polymer matrix composite materials for in-process quality control. These tasks will allow more accurate prediction of polymer composite performance in commercial application.

- Complete first measurements of thin film structures using the neutron reflectometer developed in a joint program with IBM Almaden Research Center. These measurements will be possible because the new reflectometer extends current U.S. capabilities by more than five times. This will provide a new tool for study of material interfaces such as occur in electronics and coatings.

- Develop test methods and evaluate materials data for advanced metal, ceramic, polymer, and composite materials for microelectronics packaging, a critical materials technology supporting semiconductor electronics. This work will include development of techniques and procedures for measuring, especially at the microscale, critical properties of materials in the packaging.

Bureau of Mines

Highlighting the Bureau of Mines' FY 1992 Materials Research program is a thrust toward more fundamental research on synthesis of composites, powder processing, and performance characterization of advanced materials. The Materials Research element now includes research addressing substitutes for hazardous or environmentally incom- patible materials. It no longer focuses exclusively on strategic and critical materials. The Minerals Research element focuses on advanced extraction technology, recovery from primary sources, and recovery from scrap and wastes.

NATIONAL SCIENCE FOUNDATION
($ in millions)

	FY 1990	FY 1991	FY 1992
BIOLOGICAL, BEHAVIORAL, SOCIAL SCIENCES	4.00	4.00	6.00
MATHEMATICAL AND PHYSICAL SCIENCES	120.11	125.68	139.68
ENGINEERING			
Chemical and Thermal Systems	30.79	33.01	38.26
Electrical and Communications Systems	21.65	23.68	32.48
Mechanical and Structural Systems	7.00	7.54	10.39
Design and Manufacturing Systems	0.00	0.91	1.91
TOTAL NSF	183.55	194.82	228.72

DEPARTMENT OF ENERGY
($ in millions)

	FY 1990	FY 1991	FY 1992
FOSSIL ENERGY-Coal			
Materials	6.38	6.55	6.34
Fuel Cells	1.46	1.44	1.60
Heat Engines	21.15	23.61	0.00
MHD	0.10	0.10	0.00
ENERGY CONSERVATION			
Industry Sector	31.02	39.49	36.28
Buildings Sector	3.80	5.01	5.24
Transportation Sector	54.82	62.63	81.91
GENERAL ENERGY SCIENCES			
Superconducting Supercollider	67.19	108.90	92.59
BASIC ENERGY SCIENCES			
Materials Sciences	196.20	274.90	257.10
ENERGY SUPPLY R & D			
Solar	1.91	1.97	1.00
Photovoltaic Systems	20.63	22.65	23.06
Solar Thermal Energy Systems	8.14	6.67	7.90
Electric Energy Systems	8.99	12.41	16.90
Energy Storage Systems	7.81	9.08	3.2
TOTAL DOE	429.60	575.41	533.12

NASA
($ in millions)

	FY 1990	FY 1991	FY 1992
AERONAUTICAL RESEARCH AND TECHNOLOGY	68.21	77.11	82.90
SPACE RESEARCH AND TECHNOLOGY	52.56	52.00	69.30
TRANSATMOSPHERIC RESEARCH & TECHNOLOGY	59.00	95.00	72.00
MATERIALS PROCESSING IN SPACE	101.89	102.30	125.80
TOTAL NASA	281.66	326.41	350.00

DEPARTMENT OF DEFENSE
($ in millions)

	FY 1990	FY 1991	FY 1992
ARMY	50.02	54.74	41.69
NAVY	59.35	61.19	84.73
AIR FORCE	67.69	77.75	87.13
DARPA	185.05	278.41	278.50
TOTAL DoD	362.11	472.09	492.05

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
($ in millions)

	FY 1990	FY 1991	FY 1992
MATERIALS SCIENCE AND ENGINEERING	23.16	26.50	28.67

BUREAU OF MINES
($ in millions)

	FY 1990	FY 1991	FY 1992
MINERALS AND MATERIALS RESEARCH	26.44	26.86	25.45

Chapter 26

Mechanical Engineering in the FY 1992 Budget

American Society of Mechanical Engineers

Nelson Milder

Introduction

Mechanical engineering research and development (R&D) is pervasive in federally supported programs. Although precise portions of individual agency R&D budgets devoted to mechanical engineering activities cannot be specified, the following review identifies those elements of the R&D budget request that are known to include strong mechanical engineering components. This analysis of the Bush Administration's FY 1992 plan is more detailed than in previous years including, for the first time, an analysis of the R&D components of the Department of Defense budget.

Table I puts agency budgets for mechanical engineering-related R&D into perspective. Three agencies, Department of Defense (DOD), NASA, and Department of Energy (DOE), represent 98 percent of the total funding with Defense (64 percent) being dominant. An overall comparison with previous years' allocations is not given since comparable figures for DOD have not been developed. More detailed analyses of R&D funding trends for each agency are provided in the sections which follow.

TABLE I Mechanical Engineering R&D (Thousands of dollars)

	Actual FY 1990	Est. FY 1991	Proposed FY 1992
Department of Energy	1,057,524	1,149,967	1,100,483
National Science Foundation	102,290	111,230	123,500
Nat'l Aero. & Space Admin.	5,227,700	6,023,600	7,198,500
Nat'l Inst. of Stand. & Tech.	145,200	166,220	201,800
Environmental Protection Agency	72,716	61,574	57,612
Department of Defense			15,598,100
		TOTAL	$ 24,279,995

The Department of Energy

Department of Energy programs would experience a total decrease in mechanical engineering-related R&D due principally to reductions in funding for the Fossil Energy R&D program. Other areas are programmed for modest increases generally. Additional programs which have not been included in previous analyses for mechanical engineering R&D but which will involve substantial funding in future years include technology development within the Environmental Restoration and Waste Management program, Fusion Energy Research, and the Superconducting Supercollider. These activities represent a total of $832.521 million in FY 1992.

The FY 1992 request for Basic Energy Sciences (BES) programs includes approximately $11 million for mechanical engineering-related activities within the Material Sciences program for non-destructive evaluation, welding technology, and micro-mechanics research. In addition, $7 million of the $16.1 million request for engineering research is to be applied to mechanical engineering research in robotics, fluid mechanics, multi-phase flow, heat transfer, solid mechanics and fracture mechanics. These figures represent about a four percent increase over the FY 1991 allocations.

Within the Fossil Energy R&D program, major reductions are proposed in the coal (60 percent reduction), petroleum (12 percent reduction), and gas (50 percent reduction) R&D programs, including termination of the magnetohydrodynamics, heat engines, underground coal gasification, and oil shale programs.

The request for the Solar Energy program reflects an increase from $129.4 million in FY 1991 to $142.8 million in FY 1992, including an increase of 10 percent for Photvoltaics, 4 percent for Solar Thermal, 11 percent for Biofuels, and 26 percent for Wind Energy. No FY 1992 funding is indicated for Ocean Energy systems or for Diurnal Thermal Energy Storage. Energy storage systems would experience a 43 percent funding decrease.

In the administration's FY 1992 budget request, energy conservation is divided into end-use categories: buildings, industry, transportation, and utilities. These categories incorporate R&D activities of importance to mechanical engineering as listed in the appropriate sections of Table II. There would be a major increase in Electric and Hybrid Vehicle R&D from $25 million in FY 1991 to $41.6 million in FY 1992. Alternative Fuels Utilization would increase from $13.7 million for $16 million, and Advanced Materials would increase from $15.4 million to $20.8 million.

Consistent with the President's proposed National Energy Strategy's promotion of electrical energy production technologies, the FY 1992 request for the Nuclear Energy program represents a 39 percent increase over the FY 1991 allocation. This includes a $24.2 million increase for light water reactor programs, a $22.7 million increase for space power reactor systems, and initiation of a new space exploration initiative at $30 million. The request calls for reductions in the Advanced Reactor R&D program and in Advanced Radioisotope Power Systems totaling $26.2 million.

The University Program's nuclear engineering support activity, previously funded within the Office of Energy Research, has been transferred to the Nuclear Energy Program Office in FY 1992. This activity is vital for ensuring the future availability of the engineering skills required to support a viable nuclear energy industry.

TABLE II Department of Energy
(Thousands of dollars)

	Actual FY 1990	Est. FY 1991	Proposed FY 1992
Basic Energy Sciences			
Engineering Research	15,168	14,935	16,370
Materials Science	140,291	150,508	156,674
Fossil Energy			
Coal	276,138	289,066	115,010
Gas	14,429	15,890	8,000
Petroleum	39,034	59,033	52,175
Conservation			
Building Systems	8,844	15,608	21,642
Community Systems	4,094	3,255	2,800
Tech. & Cons. Products	12,934	15,890	15,130
Appliance Standards	1,725	1,990	2,500
Fed. Energy Management	1,150	2,984	4,550
Waste Energy	13,955	16,911	38,662
Industry Process Eff.	26,656	33,255	28,478
Industry Cogeneration	5,073	4,079	3,264
Vehicle Propulsion	17,257	15,817	16,513
Energy Conservation & Utiliz.	26,276	25,664	24,106
Other			
Solar	93,317	129,418	142,878
Geothermal	17,182	27,252	20,170
Electric Energy Systems	16,874	27,988	30,757
Energy Storage Systems	11,716	12,746	7,246
Nuclear Energy	308,549	275,778	385,808
University Programs	6,822	11,900	7,750
TOTAL	$1,057,524	$1,149,967	$1,100,483

National Science Foundation

NSF research programs that involve mechanical engineering would grow at 11 percent over the FY 1991 level. This is significantly less than both the 17.5 percent overall increase proposed for NSF and the 19.1 percent rise slated for overall engineering research at the Foundation.

The $12.27 million increase in proposed mechanical engineering research includes $4.5 million for increased funding of existing Engineering Research Centers plus establishing eight to ten new Industry/University Cooperative Research Centers. An indeterminate portion of these are mechanical engineering-related. Without these programs included, the traditional small programs for funding one to a few faculty plus some graduate students are budgeted at about $68.3 million, an increase of 12.8 percent, still well below the overall NSF and directorate increases.

The research programs (not including centers) shown in Table II show increases of from 4.1 to 27 percent, indicating significant programmatic emphasis changes within the Foundation. The proposed $50 million initiative for Academic Research Instrumentation for "retooling the nation's academic research laboratories" could have a major impact on mechanical engineering research.

TABLE III National Science Foundation (Millions of dollars)

	Actual FY 1990	Est. FY 1991	Proposed FY 1992
Mech. & Struc. Systems			
Dynamic Syst. & Cont.	3.05	3.52	4.47
Surf. Eng. & Tribology	2.03	2.50	2.75
Mechanics & Materials	8.26	8.45	9.65
Design & Mfg. Systems			
Oper. Res. & Prod. Sys.	4.59*	5.09*	5.30*
Des. & Computer-Int. Engineering	4.90	5.00	5.60
Mfg. Process. & Equipment	9.22	9.97	11.66
Chemical & Thermal Systems			
Interfacial Transp. & Separation Processes	7.48	8.73	9.90
Thermal Systems	7.42	8.11	9.15
Fluid, Part. & Hydraulic Sys.	8.96	9.19	9.85
Engineering Centers			
Engineering Res. Centers	42.51	45.77	48.27
Ind./Univ. Coop Res. Centers	3.86	4.90	6.90
TOTAL	$102.29	$111.23	$123.50

*not including intern stipends

National Aeronautics and Space Administration

NASA's R&D budget for FY 1992 would see an increase of approximately $1.2 billion, or 20 percent, from FY 1991 appropriations. This represents over 60 percent of NASA's entire FY 1992 budget increase. Table IV represents the distribution of funds across NASA's R&D programs for FY 1992, and shows a comparison with previous years' appropriations. As was the case for FY 1991, the largest segment of NASA's R&D continues to be concentrated on space science ($2.9 billion) and the Space Station ($2.1 billion). The remaining $2.2 billion is divided among Space and Aeronautical Research and Technology programs to develop the U.S. technological base for aeronautics and manned and unmanned space ventures.

Although the Space Station ($103 million increase) is regarded as a critical element in this nation's exploration of space, it is currently being restructure by congressional mandate to achieve a more incremental approach as defined by near-term and out-year budgets.

Space Transportation Capability Development ($880 million), increases funding by $275 million for Spacelab, high orbit upper stage development, payload and engineering technology bases, and a new Start-A launch system designed to provide the U.S. with flexible heavy lift capability.

The Space Science and Application Programs ($2.9 billion) receive an increase of almost $500 million as further emphasis is placed on NASA's fundamental role of examining the origin and evolution of our universe, the stars, and our planet. A highlight of this program which touches on mechanical engineering includes the design and development of the Advanced X-ray Astrophysics Facility, whose budget doubles to $211 million as the design process begins in FY 1992.

Aeronautical research and Technology ($591 million) receives an $80 million increase in FY 1992 to continue NASA's role in strengthening U.S. leadership in aviation. This broad technology base for aeronautical development continued to hold strong mechanical engineering involvement to understand the phenomenon and methodologies associated with viscous flow systems, multi-state turbomachinery, advanced composite materials, and flight systems research.

Throughout NASA's R&D budget, mechanical engineering is involved with systems management, quality assurance, and reliability/safety assessment. In addition, NASA's academic programs support mechanical engineering through aerospace education program, faculty fellowships, graduate student research grants, minority university research programs, and space grant college fellowships.

TABLE IV National Aeronautics and Space Administration
(Millions of dollars)

	Actual FY 1990	Est. FY 1991	Proposed FY 1992
Space Station	1749.6	1900.0	2028.9
Space Trans. Capability Dev.	558.1	602.5	879.8
Space Science & Applications			
Physics & Astronomy	859.4	975.1	1140.6
Life sciences	106.1	138.8	183.9
Planetary Exploration	390.8	457.1	627.3
Earth sciences	434.2	667.9	775.6
Materials processing	101.9	102.3	125.8
Communications	77.7	52.5	39.4
Information systems	28.2	36.7	42.0
Commercial Programs			
Technology utilization	23.7	24.4	32.0
Commercial use of space	32.8	61.6	118.0
Aeronautics and Space Technology			
Aeronautical research & tech.	442.6	512.0	591.2
Transatmospheric res. & tech.	59.0	95.0	72.0
Space research & tech.	284.1	290.4	421.8
Safety, Reliab. & Qual. Assurance	22.6	33.0	33.6
Academic Programs	37.5	55.1	64.6
Tracking and Data Advanced Sys.	19.4	20.0	22.0
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TOTAL	$5,227.7	$6,023.6	$7,198.5

National Institute of Standards and Technology

The FY 1992 request of $248 million for NIST contains an overall $33 million increase over last year. The majority of the funding request ($208.1 million) is allocated to core R&D programs herein considered relevant to mechanical engineering. The remaining funds ($46.2 million) go to the extramural Manufacturing Technology Centers (MTC) and Advanced Technology Programs (ATP). Perhaps the most noteworthy feature of this budget proposal is its long-term projection which will approximately double NIST's budget to $430 million by 1996. If approved, this budget increase would mark a 50 percent increase in the agency's budget since FY 1990.

The programs listed in Table V are concentrated in NIST's Scientific, Technical Research, and Services activities. The most significant single increase is for Electronics and Electrical Measurements, for which a 57.9 percent hike from $21.3 million to $33.6 million is proposed. The increase will support several new projects including the establishment of a formal program in Magnetic Measurement Technology and expansion of the highly successful Fundamental Research program in superconductivity. Other notable increases include a 52.6 percent increase (to $12.6 million) for the Manufacturing Engineering program, a 27.3 percent increase (to $15 million) for the Computer Systems program, and a 27.7 percent increase (to $37.8 million) for Research Support activities.

Not shown on the Table is the funding picture for Industrial Technology Services, which include the Advanced Technology Program and Manufacturing Technology Centers. The largest decreases for NIST are included in these areas of the Administration's proposal. Decreases in the FY 1992 extramural appropriations request include $1.6 million less (to $10.3 million) for the MTC due to planned carry-over funding of $3.4 million from FY 1992 and a $1.3 million decrease due to the phasing out of the State Technology Extension Program because its functions are being accomplished through other programs. ATP is slated to receive $35.6 million, equal funding to FY 1991.

TABLE V National Institute of Standards and Technology
(Millions of dollars)

	Actual FY 1990	Est. FY 1991	Proposed FY 1992
Scientific & Technical Research & Services			
Electronics & elec. measurements	16.2	21.3	33.6
Manufacturing engineering	6.2	8.3	12.6
Chem. science & technology	16.9	18.6	20.8
Physics	24.8	25.5	26.5
Materials science & engineering	23.2	26.5	28.7
Building & fire research	11.3	9.8	10.6
Computer systems	9.4	11.8	15.0
Applied math. & sci. computing	5.6	5.8	6.1
Technology assistance	7.4	9.0	10.0
Research support activities	24.3	29.6	37.8
TOTAL	$ 145.2	$ 166.2	$201.8

Environmental Protection Agency

Funding for Environmental Engineering and Technology research programs at EPA is projected to decrease by six percent, from $61.57 million in FY 1991 to $57.61 million in FY 1992. EPA research and development priorities change according to the regulatory technical support needs of the agency.

The Air program is scheduled for a substantial cut in research due to the fact that continued funding for earlier coke oven emissions studies is not included in the FY 1992 budget. Funding for Water Quality research will increase slightly to continue research efforts in sludge incineration and wetlands systems.

EPA's Hazardous Waste program has been targeted for a considerable increase to provide research on oil spills, incineration, ash utilization, control of hazardous air emissions, and landfill operations. Funding for Radiation programs is slated for a modest decrease with studies continuing on radon reduction measures.

Funding for both the Toxic Substances program and Energy program will remain at FY 1991 levels reflecting no adjustments for inflation. Toxic Substances activities will focus on predicting releases and exposures to asbestos as well as asbestos clean-ups. Funding for Energy programs will support the construction and testing of the Limestone Injection Multistage Burner system. Superfund research will be reduced because the Montana Mining Waste Project and Gulf Coast Research Center Hazardous Waste Project are not carried over into the FY 1992 budget.

TABLE VI Environmental Protection Agency (Thousands of Dollars)

	Actual FY 1990	Est. FY 1991	Proposed FY 1992
Air	4,665.2	7,604.1	6,084.1
Water Quality	3,231.1	1,775.6	1,875.6
Hazardous Waste	13,855.5	11,327.3	14,082.5
Radiation	2,196.5	2,019.5	1,988.6
Toxic Substances	2,054.8	1,718.6	1,718.6
Energy	2,383.7	2,393.7	2,393.7
Superfund	44,329.5	34,735.7	29,468.7
Total	$ 72,716.3	$ 61,574.5	$ 57,661.8

Department of Defense

With regard to mechanical engineering, Defense R&D covers virtually all disciplines and areas of interest. The Defense R&D funding has, in recent years, constituted over half of the total Federal R&D spending. Government labs spend more than a quarter of the Defense R&D dollars, while over two-thirds is contracted to private industry and research centers. The major components of the military's R&D, officially known as RDT&E (Research, Development, Test and Evaluation), are Basic Research and Applied Research and Development.

As the name implies, Basic Research involves scientific study and experimentation directed toward increasing knowledge in those scientific fields related to longterm national security needs. Over half of the military's Basic Research dollars go to university programs. In the FY 1992 Defense budget, only 2.5 percent or $1.01 billion is devoted to Basic Research. If approved by Congress, Basic Research funding will suffer a 10 percent decline from the FY 1991 level.

Exploratory Development includes all efforts directed towards the solution of specific military problems, but does not involve the development of procurable hardware. An example would be breadboard design of a new electronics concept. In the FY 1992 Defense R&D budget, 7.2 percent or $2.86 billion has been designated for Exploratory Development. At this level of funding, Exploratory Development will receive a 5 percent increase over the FY 1991 figure.

TABLE VII Selected Department of Defense Basic Research and Exploratory Development Programs (Millions of dollars)

	Proposed FY 1992	Percent Change
Army		
Combat Vehicle and Automotive Technology	44.1	+23%
Night Vision Technology	30.0	+56%
Environmental Quality Technology	19.0	+50%
Medical Technology	89.6	-18%
Navy		
Anti-Submarine Warfare Technology	130.9	+5%
Nuclear Propulsion	15.3	+5%
Ocean and Atmospheric Technology	39.7	+5%
Air Force		
Materials Technology	69.2	+10%
Aerospace Flight Dynamics	71.7	+16%
Rocket Propulsion and Astronautics Technology	47.3	+27%
Defense Agency		
University Research Initiatives	87.4	-62%
Materials and Electronics Technology	62.0	-60%
Medical Free Electron Laser	20.0	0%

The majority of the Defense R&D budget is devoted to the category of Development which includes "Test and Evaluation" functions. Any R&D work which is aimed at maturing a technology so that a specific weapons system can be completed and produced is considered to be a Development program. The FY 1992 Defense budget allocates 90 percent or $36.05 billion of its R&D funds to Development. Development R&D fundings as approved by Congress has declined 12 percent over the last three years (FY 1989 to FY 1991). This translates to a 19 percent decline if it is adjusted for inflation.

TABLE VIII Selected Department of Defense Development Programs (Millions of dollars)

	Proposed FY 1992	Percent Change
Army		
Armored Systems Modernization	400.8	+1209%
Light Armed Scout Helicopter (LH)	507.8	+77%
Joint Tactical Fusion Program	130.8	+105%
Longbow Missile Program	233.2	+21%
Sense and Destroy Armament Missile	150.8	+45%
Navy		
Electronic Warfare Development	142.3	+3%
Submarine Combat System	270.3	-21%
SSN-21 (Seawolf) Developments	157.4	-17%
F-14 (Tomcat) Upgrade	116.3	0%
Air Force		
National AeroSpace Plane Tech. Program	231.8	+44%
B-2 Advanced Technology Bomber	1,563.1	-10%
Short Range Attack Missile II	165.9	+11%
Intercontinental Ballistic Missile Modern.	815.9	+44%
Advanced Cruise Missile	108.7	+110%
Milstar Satellite Communications System	901.3	---
C-17 Transport Program	577.4	+8%
Advanced Tactical Fighter	1,637.2	+726%
Electronic Warfare Development	215.2	+178%
Joint Surveillance/Target Attack Radar System	311.9	+64%
Advanced Launch System	147.7	+491%
Defense Agencies		
Strategic Defense Initiative (SDIO)	5,150.6	+80%
Manufacturing Technology (DARPA)	206.2	+106%
Experimental Evaluation of Major Innovative Technologies (DARPA)	289.7	+63%
Defense Mapping, Charting, and Geodesy (DMA)	226.8	+1%
Airborne Reconnaissance Support Program (DSPO)	222.8	+869%

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Colloquium Proceedings: 1976–1982 and 1984–1990

From 1976 through 1982, the annual AAAS R&D Colloquia were held in June; from 1984 through 1986, in March; and since 1987, in April, following publication of the latest *R&D Report*. The *Proceedings* of these Colloquia were published separately each year and, in general, include the texts of speeches delivered during the meetings and in some cases edited versions of the discussions that followed. (The *Proceedings* of the 1983 Colloquium are included in *AAAS Report VIII*).

Preliminary Analyses: FY 1979–FY 1984

Prepared by an Intersociety Working Group comprised of representatives of several scientific, engineering and higher education associations, these reports review, in a preliminary fashion, the overall federal budget for R&D, the R&D budgets of several major R&D agencies, and the R&D funding situation in a number of scientific and engineering disciplines. In general, they are published within a few weeks after release of a given year's budget.

Congressional Action on R&D in the Federal Budget: FY 1979–FY 1991

These brief reports, published in the fall, are also prepared in collaboration with the Intersociety Working Group. They summarize the results of congressional action on R&D elements in the federal budget. Their format permits comparison between the President's proposals for a given fiscal year and congressional allocations.

R&D in the 1980s: A Special Report

This report, prepared in the fall of 1988, reviews the history of R&D policy and funding in the Reagan years.

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